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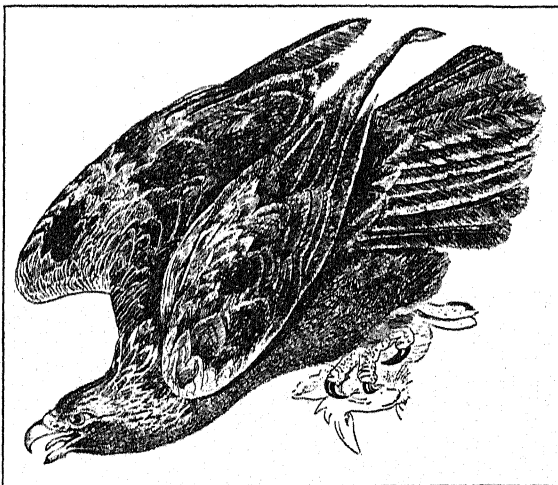
METHOD OF CROSS REFERENCES

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The National Encyclopedia

EADS E GLINKA

EADS, JAMES BUCHANAN (1820-87), American hydraulic and bridge engineer, was born at Lawrenceburg, Ind., May 24, 1820. In 1839 he obtained work on a river steamboat. His first invention was a boat designed to raise sunken steamers. At the outbreak of the Civil War he was summoned to Washington, D.C., by the Federal Government, and in 100 days built eight iron-clad steamers for use on the Mississippi River. Later he constructed mortar-boats, which were of naval and transport value to the Union. He built an arch bridge across the Mississippi River at St. Louis, Mo., in 1867-74, and was successful in opening the South Pass, one of the mouths of the Mississippi River into the Gulf. He failed to get Congressional approval of his proposal to build a ship-railroad across the Tehuantepec Isthmus, a project he believed more practicable than the Panama Canal then under discussion. He died at Nassau, Bahama Islands, Mar. 8, 1887.



AFTER AUDUBON, BIRDS OF AMERICA

GOLDEN EAGLE
Aquila chrysaetos canadensis

EADS BRIDGE, an arched cast-steel bridge over the Mississippi River at St. Louis, completed in 1874 by James Buchanan Eads (1820-87). Congress approved the construction of the bridge in 1867. The roadway of the bridge is supported by three unhinged rib-arch structures, with a center arch of 520 feet in span, resting on masonry piers sunk 136 feet below

high water. The maximum height above high water is 55 feet. The approach on the St. Louis side is by way of a tunnel beneath the retail district. The approach on the east side is by an elevated roadway over the Illinois lowlands. The total length of the bridge, including the tunnel section, is 6,220 feet, and the total cost \$10,000,000. There are two decks, one for vehicular and pedestrian, the other for railroad traffic.



G. M. SUTTON, "BIRDS OF PENNSYLVANIA"
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AMERICAN OR BALD EAGLE
Haliaeetus leucocephalus

EAGLE, a popular name for any large and fierce bird of prey, but in science restricted mainly to the genera *Aquila* and *Haliaeetus* with about 40 species found throughout the world. The true eagles inhabit mountain ranges or wild seacoast, are rather slow in flight, inclined to be silent and to seize their prey by a sudden pounce, but are not averse to carrion; thus they resemble vultures more than falcons. The term eagle in the Bible refers to the lammergeier, a great vulture much feared by the shepherds of Asia Minor. Eagles make big nests of sticks and sea-weed in tall trees, or on cliff-ledges. The nests are repaired and re-occupied by successive generations for many years. A typical species of *Aquila* is the dark-colored eagle, which was called Bird of Jove by the Romans, and has figured in the emblems of all European empires;

it is represented in North America by the golden or war-eagles of our western mountains. The celebrated harpy of Mexico is strong enough to seize rattlesnakes, monkeys, foxes, and similar animals. To the sea-eagles (*Haliaeetus*) belongs the white-headed or bald eagle, symbol of the United States. It feeds mainly on fish, often obtained by robbing fish-hawks and gulls of their catches. E. I.

EAGLE PASS, a port city in southwestern Texas, the county seat of Maverick Co. It is situated on the Rio Grande River, opposite Piedras Negras, Mexico, 150 mi. southwest of San Antonio, Tex.; the city is served by the Southern Pacific Railroad. Coal mines lie in the vicinity. The countryside has very fertile soil; grain and truck garden produce, especially spinach and onions, are the leading crops. Pop. 1920, 5,765; 1930, 5,059.

EAGRE, a word uncommonly used to describe the phenomenon, better known as a BORE, which consists of a huge tidal wave running up the estuaries of tidal rivers, or shallow, funnel-shaped bays. Its use appears to be restricted chiefly to the rivers Humber and Trent in England.

EAKINS, THOMAS (1844-1916), American painter and sculptor, was born in Philadelphia, July 25, 1844. After studying at the Pennsylvania Academy, he was an instructor there and in Paris. For a number of years he taught anatomy in the Pennsylvania Academy. He painted portraits of Louis Kenton, Cardinal Martinelli, Carroll Beckwith, Dr. Gilbert L. Parker and P. Hayes Agnew. His finest painting, *Clinic of Professor Gross*, is in Jefferson Medical College, Philadelphia. Other works are *The Chess Players*, in the Metropolitan Museum, New York; *The Cello Player*, Pennsylvania Academy; *The Clinic of Professor Agnew*, University of Pennsylvania; and *The Crucifixion*, Overbrook Seminary. He modeled the horses on the Brooklyn Soldiers' and Sailors' Monument and two reliefs on the Trenton Battle Monument. Eakins was a virile painter, reserved and sober in style and notable for his plain, unadorned realism. He died at Philadelphia, June 25, 1916.

EAMES, EMMA (1867-), American soprano, was born at Shanghai, China, Aug. 18, 1867. One of MATHILDE MARCHESI's accomplished pupils, she made her début, as Juliette in Gounod's opera, at the Paris Opéra in 1889, achieving immediate success, repeated later at London and New York. Her celebrated rôles were those of Marguerite, Juliette, Elsa, and Tosca.

EAR, the organ of hearing whose functions is also to aid in the sense of equilibrium or balance. According to its structure the ear is divided into three parts: the outer ear, the middle ear and the inner ear. The external ear and the middle ear together form the sound conducting apparatus. The inner ear constitutes the sound perceiving apparatus, and is the part which helps maintain the equilibrium.

The external ear, composed chiefly of skin and cartilage and to a lesser extent of bone, is made up of the auricle or flap of the ear, and a canal, called external auditory canal. In many animals the auricle

is well developed, and has muscles which move it freely, so that faint and distant sounds may be the more easily caught and conducted to the inner portions. In man the external ear in this respect is a decadent organ with these muscles poorly developed, although here and there an individual is found who may be able to move his ears freely.

The auricle leads into a canal lined with skin which ends at a membrane, called the membrana tympani or drum membrane. In the skin of the canal are numerous glands, among them the cerumen glands whose function it is to secrete a waxy substance which serves

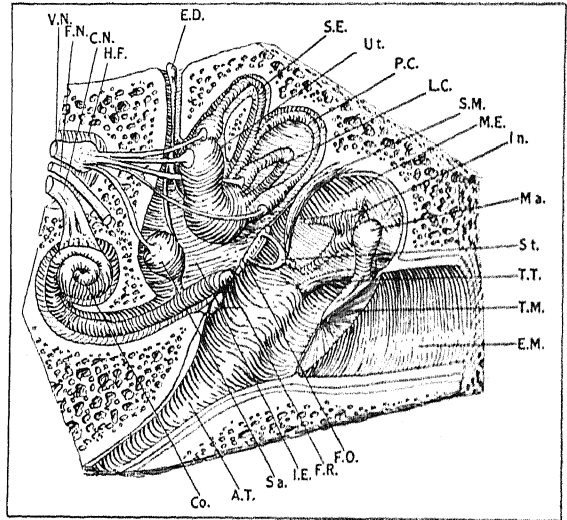


FIG. 1. SCHEMATIC VIEW OF INTERNAL PARTS OF THE EAR

A.T., auditory tube; C.N., cochlear nerve; Co., cochlea; E.D., endolymphatic sac and duct; E.M., external auditory meatus; F.N., facial nerve; F.O., fenestrum ovale (oval window); F.R., fenestrum rotundum (round window); H.F., hiatus of facial canal; I.E., internal ear, wall of bony labyrinth; In., incus (anvil bone); L.C., lateral semicircular canal; Ma., malleus (hammer bone); M.E., middle ear; P.C., posterior semicircular canal; Sa., sacculus; S.C., superior semicircular canal; S.M., stapedius muscle; St., stapes (stirrup bone); T.M., tympanic membrane (ear drum); T.T., tensor tympani muscle; Ut., utricle; V.N., vestibular nerve

partly as a lubricant and partly, it is thought, to repel insects. Behind the drum membrane is the middle ear or drum cavity, a space roughly six-sided in shape closely related to many important structures, such as the brain and large blood vessels, and containing, among other structures, three tiny bones constituting a chain. This chain extends from the drum membrane to the internal ear and transmits sound which has been directed into the external ear, across the middle ear cavity to the internal ear. Delicately jointed and hinged, this bony chain is very sensitive and marvelously adapted for its purpose. Each element in the chain has a name derived from its supposed resemblance to the object for which it is named; thus they are known as the hammer or malleus, the anvil or incus, and the stirrup bone or stapes.

Leading into the middle ear cavity from the nasopharynx, or that part of the throat back of the nose, is a tube, called the Eustachian tube. In health this tube is opened into the throat chiefly by the act of swallowing, and air enters the middle ear cavity

and so maintains an equal pressure on both sides of the drum membrane, a state necessary for the proper function of the middle ear. It is up this Eustachian tube, moreover, that infections may invade the middle ear in the presence of colds in the head.

Directly back of the middle ear and closely related to it, is a curious structure whose function is not entirely understood and which is called the mastoid process. It consists of bone hollowed out, honeycomb-

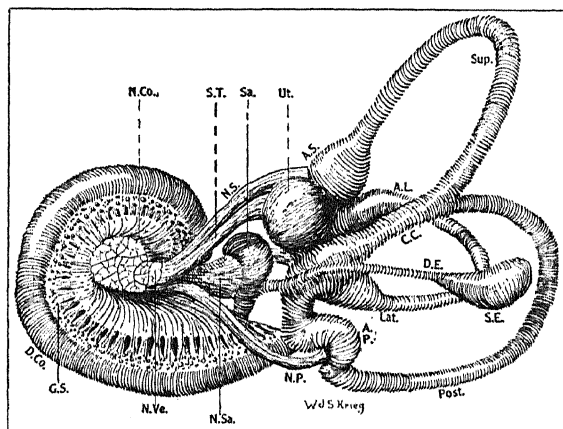


FIG. 2. MEMBRANE LABYRINTH OF THE RIGHT HUMAN INNER EAR, SEEN FROM THE LEFT AND BEHIND

A.L., lateral ampulla; A.P., posterior ampulla; A.S., superior ampulla; C.C., common crus; D.Co., cochlear duct; D.E., endolymphatic duct; G.S., spiral ganglion of cochlear nerve; Lat., lateral semicircular canal; N.Co., cochlear nerve; N.P., nerve to posterior ampulla; N.S., nerve to superior ampulla; N.Sa., nerve to saccule; N.Ve., vestibular nerve; Post., posterior semicircular canal; Sa., saccule; S.E., endolymphatic sac; Sup., superior semicircular canal; S.T., superior terminal branch of vestibular nerve; Ut., utricle

like, into numerous little air cells, all connecting with one another. Diseases of the middle ear are easily transmitted to the mastoid process and in violent inflammation all the tiny air spaces may be filled with pus, a menacing situation when one considers the close approximation of the mastoid process to the brain and other vital structures.

Sounds having been carried into the external ear canal, aided to a minor extent perhaps by the auricle, are transmitted by the delicate chain of tiny bone or ossicles and arrive at the internal ear. This structure, deeply imbedded in the bone of the skull, is small, and contains organs of extreme delicacy, namely, the cochlea, the semicircular canals, the saccule and utricle.

The cochlea is the essential organ of hearing or the sound perceiving apparatus. It is a tiny membranous tube coiled like a snail shell upon itself and containing delicate highly specialized cells arranged in the so-called organ of Corti. Sound sensations, having arrived here, are transmitted by the auditory nerve to those centers in the brain which are set aside for them. It is in these brain centers that those vibrations in our environment which we call sound are interpreted as such.

Apart from the cochlea, as we have said, the internal ear contains the delicate and tiny membranous organs devoted to sense of equilibrium. These organs are

three semicircular canals, arranged so as to occupy the three planes in space, as well as two sac-like structures, the utricle and saccule, whose functions are not well understood. All of these organs buried in bone are shielded externally and bathed internally by a fluid and contain groups of highly specialized cells having connections with the brain, and it is partially through the medium of the semicircular canals that equilibrium or balance is maintained. See also BRAIN.

S. J. P.

EAR, NOSE AND THROAT, DISEASES OF.

The Ear. The ear has three main parts, the external, the middle and the internal ear. The *external ear* is composed of the concha, a shell-like structure designed to collect sound, and the external auditory canal leading from it to the margin of the drum. Except for malformations of the auricle and infections of the skin, the external ear is rarely the seat of disease.

The *middle ear* is a cavity bound by the tympanic membrane or eardrum on its external side. The drum receives and transmits sound waves to the ossicles, a chain of three tiny bones, which, in turn, transmit them to the labyrinth in the internal ear. The latter has a dual function, the perception of sound and the maintenance of equilibrium.

The diseases of the middle ear fall into two main divisions, catarrhs or inflammations and infections. An acute middle ear catarrh may result from closure of the Eustachian tube, which connects the nasopharynx with the tympanic cavity. These attacks usually follow colds. If they are repeated over a long period, a chronic catarrhal otitis media may develop with a resultant loss of hearing and head noises.

If the middle ear space becomes infected, an abscess may form, causing the drum to rupture or requiring incision. Purulent otitis media is a frequent complication of measles, scarlet fever, diphtheria, grippe, pneumonia, tonsillitis, common colds and sinusitis. If the disease in the middle ear spreads to the adjoining mastoid process, an acute mastoiditis occurs. (See MASTOID AND MASTOIDITIS.) There are certain factors which predispose to the chronicity of middle ear and mastoidal infections. Some of these chronic lesions are dangerous to life because they eventually cause a meningitis or brain abscess. (See also MÉNIÈRE'S DISEASE; MEASLES; MENINGITIS; POLYPUS.)

Sometimes the *internal ear* is affected by the extension of an infection from the middle ear or mastoid. A diffuse purulent labyrinthitis is apt to be complicated by a fatal meningitis or brain abscess. If the cochlear portion of the labyrinth is destroyed by injury or disease, hearing is destroyed with it. Involvement of the semicircular canals produces equilibratory disturbances.

Hearing may be reduced by interference with the mechanical transmission of sound (by destruction of the drum or interference with the motility of the ossicular chain) or by injury to the auditory nerve or the labyrinth. Certain hereditary conditions produce a chronic progressive deafness known as otosclerosis,

The Nose. The nose is divided by a bony wall called the septum. On each lateral wall are three bones called turbinates. A deviation of the septum, through injury or improper development, or a catarrhal hypertrophy of the turbinates, may lead to obstruction of the channels for respiration and drainage. Adjoining and opening into the nose, are the nasal accessory sinuses, air spaces in the surrounding bony structure. An infection of a sinus is known as sinusitis. Repeated attacks of acute sinusitis, without proper drainage, may produce a chronic suppuration involving any or all of the sinuses. (See SINUSES AND SINUSITIS; also POLYPUS.)

The Tonsils. The tonsils, a protection against infection at birth, lose their function at about two years and should atrophy. If they persist, they may become sufficiently enlarged to interfere with respiration or they may act as a focus of infection. (See TONSILLITIS.) ADENOMAS are an abnormality frequently encountered in the nasopharynx. S. J. K.

EARHART, AMELIA (1900-), American aviatrix, settlement worker and author (whose married name is Mrs. George Palmer Putnam), was born at Atchison, Kan., in 1900. She attended private schools at Atchison, Ogontz School at Philadelphia in 1916, and matriculated for medicine at Columbia University in 1919. In 1918 she qualified as a V.A.D. for war work under the Canadian Red Cross. She joined her parents in Los Angeles in 1920, where she trained for aviation at Rogers Airport and Kinner's Field, Long Beach, Cal. A year later, she took up teaching and settlement work in Boston, became identified with Denison House in 1926 and, later, was elected to the Board of Directors. She was one of five incorporators of Denison Aircraft Corporation who established a commercial airport at Squantum in 1928, and revived her aviation activities. In 1928, when the Honorable Mrs. Frederick Guest, of London, bought the Byrd tri-motor Fokker monoplane, "Friendship," to sponsor the first transatlantic flight to be made by a woman flier, Amelia Earhart was selected to accompany Wilmer Stultz, pilot, and Lou Gordon, mechanic, on the proposed flight. Taking off from the Jeffry Yacht Club moorings, East Boston, June 3, 1928, they were forced down in Halifax. Proceeding to Newfoundland, they took off from Trepassy, June 17, and 20 hrs. 40 min. later, landed at Burry Port, Wales. The first woman to fly the Atlantic, she was officially welcomed in London and in New York, Boston and other cities upon her return. She is the author of *20 Hrs. 40 Min.*, an autobiography and log of the flight. Amelia Earhart subsequently became vice-president of the New York, Philadelphia and Washington Airways Corporation and president of the Boston Chapter of the National Aeronautic Association.

On May 21, 1932, Mrs. Putnam made the first solo flight by a woman across the Atlantic Ocean, and set a new record, 15½ hours, for all trans-Atlantic flights. Her course was from Harbor Grace, N.F., to Londonderry, Northern Ireland. For this achievement she

received many European honors, and was awarded the Distinguished Flying Cross by Congress and the National Geographic special gold medal.

EARLE, RALPH (1751-1801), American painter, was born at Leicester, Mass., May 11, 1751. He was painting portraits in New Haven, Conn., in 1774, and in 1775, after visiting Lexington and Concord, made four paintings of the battles and scenery there. These are believed to be the first historical paintings produced in America. After the Revolution, Earle went to London, studied with Benjamin West and was elected to the Royal Academy. He returned to the United States about 1786 and continued to paint portraits in Massachusetts, New York and Connecticut. His portrait of Lady Williams is in the Metropolitan Museum, New York. Earle died at Bolton, Conn., Aug. 16, 1801.

EARLHAM COLLEGE, at Richmond, Ind., a privately controlled coeducational institution, affiliated with the Society of Friends. It opened in 1847 as a Friends' Boarding School, and was organized as Earlham College in 1859. The college had productive funds in 1931 of \$1,370,246. The library of 40,805 volumes contains special collections of Quaker material. In 1930 there were 490 students and a faculty of 40, headed by Pres. William Cullen Dennis.

EARLY CHRISTIAN STYLE, in art and architecture, a loose term covering the building and decorative art of the early church, especially in Rome, and covering not only the work in the Catacombs, but also the basilicas built from the time of Constantine until well into the Middle Ages. During the period before the official christianization of Rome, Christian work was largely parallel to contemporaneous pagan work, only changes in symbolism marking the differences.

A great increase of Eastern influence during the later Empire, however, made the Basilican church art of Rome markedly different from the imperial styles of earlier times. In general, structure was simple, and architectural members were treated with a slowly dying skill. There was much re-use of earlier architectural fragments, often with little thought of consistency. Decoratively, on the other hand, there was great lavishness, in which Eastern influences were strong. Floors were covered with combinations of Opus Sectile, or marble slabs cut especially for their positions, and Opus Alexandrinum, or mosaic bands and fields made of standard or stock size and shape units. (See MOSAIC.) Walls were often sheathed in marbles. Especially noteworthy was the rich decoration of the choir screens, the ambones (see AMBON), the paschal candlestick, and the glass decorative mosaics, often showing definite Byzantine influences, that covered the triumphal arches of the churches, the semi-domes over the apses and occasionally the upper walls of the nave.

Characteristic examples of the style are the decorations of the Catacombs of Callixtus and Domitilla; the church of Santa Maria Antiqua, in the Forum; the basilicas of St. Paul's Outside the Walls, built in 386 and rebuilt 1854 after a fire in 1825; Santa Maria in

Trastevere, 4th and 12th centuries; Santa Maria in Cosmedin, 8th century, baldachino later; San Lorenzo Outside the Walls, showing the use of Roman details, 6th and 13th centuries, and San Clemente, 1108, with choir furnishings from an earlier 9th century church.

EARLY ENGLISH STYLE, in architecture, the term applied to the first period of English Gothic, dated from 1180 to 1250. It is also known as the Lancet style, from the form of the windows with their plain pointed arches. The style is marked in general by outstanding simplicity; not only are the windows without tracery, but ornamentation and sculpture are sparingly used. The Early English church has characteristic features in the height and narrowness of the arches, the sturdiness of the construction, the length of the building itself, and, in contradistinction to the French rounded chevet, a square east end. Generally, Early English is more severe than the 12th century French Gothic with which it corresponds historically, and the wall space is broader. The capitals of the columns are usually plainly molded, instead of being carved. For bibliography *see* GOTHIC ARCHITECTURE.

EARLY REPUBLICAN STYLE, in art and architecture, a vague term covering the architectural and decorative work of the early years of the United States, roughly from the end of the Revolution to 1830 or 1840. It is a style characterized by the addition of direct classic influence from the architecture first of ancient Rome and later of ancient Greece to a tradition still largely English Georgian. As the style progressed the classic influence increased, the English decreased, and there are many signs, particularly in furniture and decoration, of influence from the Empire work of France. The style as a whole reflected the then current classic enthusiasms. (*See* MODERN ARCHITECTURE; EMPIRE STYLE; GREEK REVIVAL STYLE; ROMAN REVIVAL STYLE.) The transitional early phase is well represented in many houses and churches in New England, upstate New York and Ohio. Particularly characteristic is the work of Samuel McIntire in Salem, Mass. Further south, largely through the classic architectural work of Thomas Jefferson, and the beginning of the buildings at Washington, the Roman influence was soon dominant, and spread rapidly over the rest of the country, becoming by 1810 the accepted style for official buildings. Meanwhile the Greek influence was creeping gradually into detail forms, and received a sudden new impetus from the enthusiasm that welcomed the Greek War of Independence. During the period from 1825-40 the Greek Revival almost superseded the Roman Revival everywhere; along with Greek architectural forms, the American Empire furniture was much used.

Among the leading architects and decorators of the period were Thomas Jefferson (1743-1826), Monticello, Virginia State Capitol, University of Virginia; William Thornton (1761-1828), United States Capitol; B. H. Latrobe (1766-1820), United States Capitol, Philadelphia Customs House, Cathedral of Baltimore; Robert Mills (1781-1855), Washington Monument,

Treasury Building, Washington; William Strickland (1787-1854), Tennessee Capitol, Maritime Exchange, Philadelphia; Charles Bulfinch (1763-1844), United States Capitol, Massachusetts Hospital, Massachusetts Capitol, Meeting House at Lancaster, Mass.; Samuel McIntire (born 1757), Houses at Salem, Mass.; John McComb (1763-1853), New York City Hall, with the Frenchman J. F. Mangin, Princeton Theological Seminary, Castle Garden, Montauk Point Lighthouse; Duncan Phyfe in New York (1783-1854), the New York furniture maker. For bibliography *see* MODERN ARCHITECTURE.

EARNEST MONEY, a sum paid upon the making of a contract of the sale of goods, to bind the bargain. When the contract is completed, the earnest money becomes a part of the purchase price. However, if the purchaser does not make complete payment by the date specified in the contract, the vendor is free to offer the merchandise elsewhere and retain the earnest money.

EARTH, the planet on which we live, and the third in order of distance from the sun. It revolves around the sun in one year at a mean distance of 92,870,000 miles. The orbit is elliptic, and the actual distance varies by 3,000,000 miles, the shortest distance being reached when the earth is in PERIHELION on January 1, the greatest when in APHELION, on July 1. The mean velocity in the orbit is 18.5 miles per second. The earth rotates upon an axis in one day, and owing to this rotation is not perfectly spherical but slightly flattened at the poles. Its mean diameter is 7,913 miles, its mass is about 6,592,000,000,000,000,000 tons, and its mean density $5\frac{1}{2}$ times that of water.

The surface layers of the earth have a density of about 2.7; hence the density of the interior must be much higher than the average, probably as much as 11 times that of water. This inner core, often called the barosphere, is estimated to be from 4,000 to 6,000 miles in diameter. It is composed of iron and nickel, and many times more rigid than steel, although undoubtedly at an exceedingly high temperature. It is surrounded by layers of mixed iron and rock, while the top layer, the lithosphere, consisting of pure rocks, is no more than 40-60 miles thick, and covered for two-thirds of its area by oceans. From the analysis of the rocks on the surface it has been estimated that the solid crust is between 2 and 5 billion years old, while life has existed upon the surface for about one billion years.

The rotational axis of the earth, which does not coincide with the axis of symmetry, moves slightly in the body of the earth, causing the variation of latitude. The rate of rotation, moreover, is not perfectly uniform but subject to small irregularities, caused, probably, by slight contractions or expansions of the earth's crust. The earth possesses one satellite, the Moon, which revolves about the earth in a little more than 27 days.

W. J. L.

EARTH, FIGURE OF, the term applied to the more detailed form of the earth, as deviating from a perfect sphere.

EARTHENWARE. As its name implies, the term earthenware has been generally and loosely applied to all utilitarian and ornamental articles made from clay and differing in physical characteristics from PORCELAIN and stoneware (a hard earthenware). The original classification of earthenware was local, and included the English 14th century lead-glazed, buff-clay wares. The term is not universally acceptable, because the buff and red wares of the 17th and 18th century Staffordshire potters and the colored-glaze slip and tin enamel wares of the same period would more properly come under the heading of FAIENCE. All of these products depended chiefly on the use of single clays in the bodies. Further, modern procedure has resulted in the production of bodies made from several types of clay, compounded with quartz and feldspar, and refined in the process of preparation, which have little in common with the cruder earthenware pottery of earlier times.

Earthenware is opaque and porous, with a porosity of 10 to 20%, or more. Its color ranges from white and the light creams of the Wedgwood Queen's ware to the buffs and reds of the ferruginous clays. The physical properties of earthenware and faience are similar. In fact, faience is earthenware, and the highly developed decorative processes as exemplified in MAJOLICA, Sgraffito, Barbotine and enameled processes of Delft, Rouen, and Moustiers, represent a highly decorative pottery made from comparatively crude bodies. Such products are in direct contrast to the utilitarian table-ware of the Staffordshire and East Liverpool (Ohio) types, which, while less ornate, have as a basis synthetic and more refined bodies. Yet both types, until a more precise classification is adopted, belong to the general group of pottery known as earthenware. F. H. R.

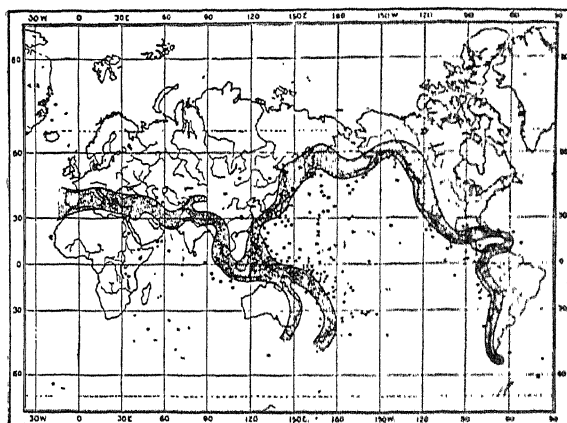
EARTH EXCAVATION is done largely by machinery under modern conditions. Manual labor is limited to small work and to cleaning up those parts of a large excavation which machinery cannot reach. In engineering SPECIFICATIONS, all material not classified as solid or loose rock is considered earth, and includes material excavated under water. "Grubbing" is removal of stumps and roots. See also EXCAVATING MACHINERY.

EARTHNUT (*Conopodium denudatum*), a perennial herb of the parsley family bearing an edible tuberous root, called also pignut. It is native to woods and pastures in western Europe including the British Isles. The smooth, slender, erect stem, rising from a globular tuber, bears much divided leaves and small white flowers in compound umbels. Various other plants with edible underground parts are called earthnut as the PEANUT, the GROUNDNUT, the CHUFA and the TRUFFLE.

EARTHQUAKE, an earth-wave, set up in major instances by sudden slipping of cubic miles of rock along a fissure, or fault. Seismographs register thousands of tremors too faint to be felt, and many distinct shocks, accompanied by subterranean rumblings, occasion little damage.

In violent earthquakes, the ground is shaken "as a terrier shakes a rat." Buildings crash, and yawning cracks appear in the earth. Disaster is often aggravated by outbreaks of fire in the ruins, by so called "tidal" waves, like that which inundated Lisbon in 1755, or by landslides.

Earthquakes tend to be chronic and acute along two distinct belts, one bordering the Pacific, the other following the Mediterranean seas. The countries



COURTESY AMER. MUS. OF NATL. HISTORY

SEISMIC MAP OF THE WORLD FOR 1899-1910

The dots represent the location of 476 major earthquakes. The shaded zone is the region of the youngest mountains

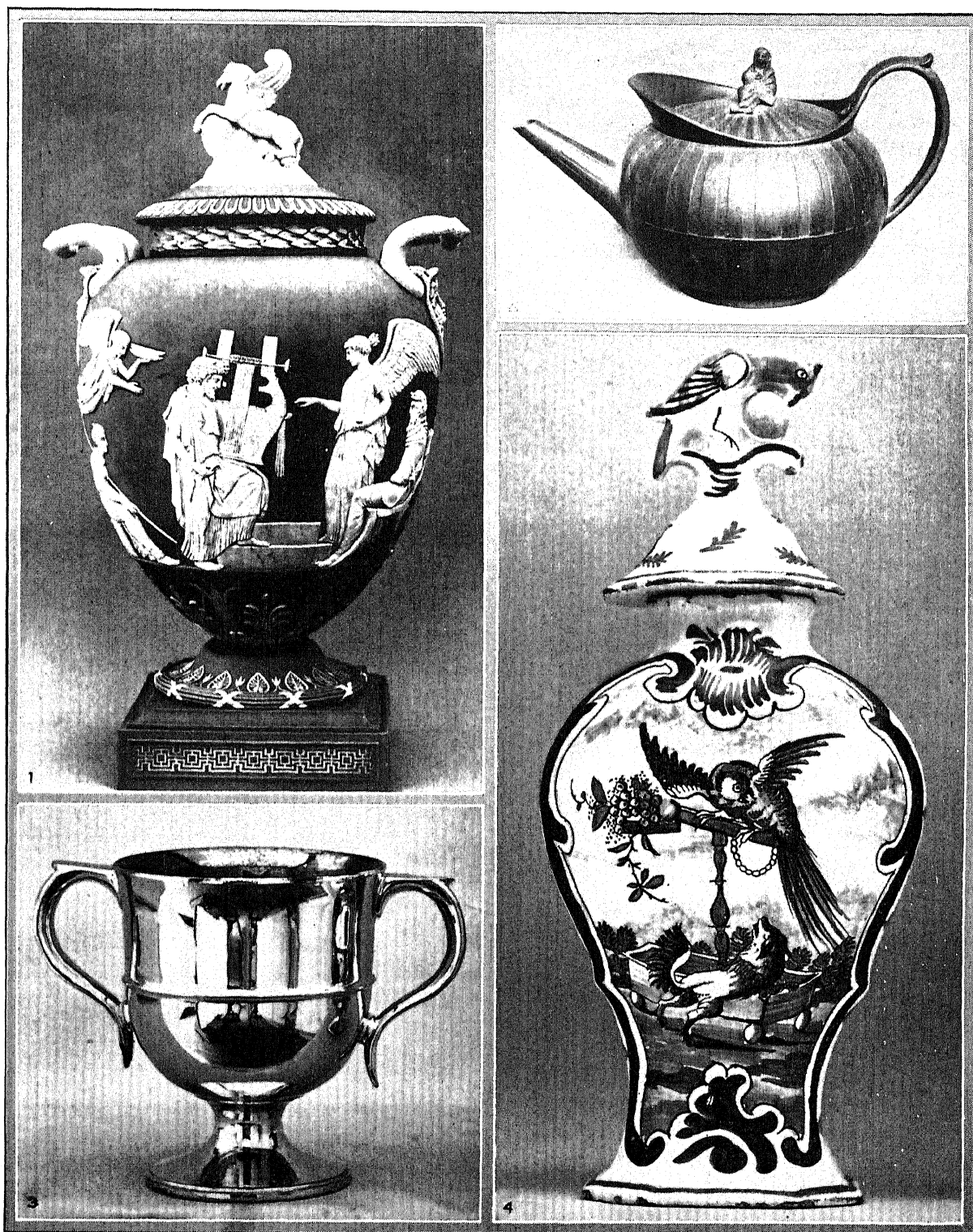
most subject to destructive shaking are Italy, China, Japan and Peru. Aside from the Charleston earthquake of 1886, important seismic disturbance in the United States has largely centered in California.

The most disastrous earthquake of history was that in India, in 1737, which took 300,000 lives. The most violent of modern times occurred in 1920, in the lowest district of China, where devastating landslides swelled the fatalities to between 180,000 and 200,000. Official records place victims of the Japanese shocks of 1923 at 99,331 dead, 33,000 missing, and 147,733 injured.

Recent major disasters have emphasized the extreme instability, in earthquake regions, of buildings erected on shallow "made" land, and the risk of laying city water-mains across a known seismic fault. The destruction of San Francisco, as of Tokio and Yokohama was completed by flames, owing to the rupture of water-mains by crustal movements along a fault. The 100,000 fatalities in the Messina earthquake of 1908 were largely accounted for by crumbling of dwellings of feebly-cemented rubble construction.

Great Japanese Earthquake. A very violent earthquake which struck the Tokyo-Yokohama region in Japan on Sept. 1, 1923. The Japanese islands, of volcanic origin, have suffered from more or less serious earthquakes for many centuries. The most serious, in terms of destruction of life and property, occurred in 1923, when Yokohama was virtually wiped out and large parts of Tokyo were destroyed by the quake and the subsequent fire. The first shocks occurred almost exactly at noon of Sept. 1, and severe

EARTHENWARE



COURTESY METROPOLITAN MUSEUM OF ART

EARTHENWARE OF ENGLAND AND THE NETHERLANDS

1. Wedgwood vase with relief decoration. 2. Wedgwood teapot of black basalt ware, 18th century. 3. Two-handled urn-shaped cup of silver and copper, lustered, part of a

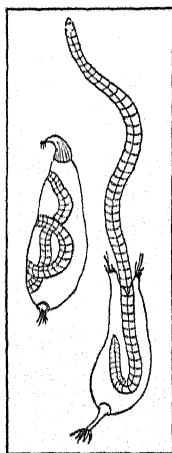
Wedgwood tea set, of the 18th century. 4. Vase with a garniture polychrome decoration from the factory of Lambertus Sanderus, Delft, dating from 1764.

shocks followed at intervals for some hours. Fire broke out at many points very soon after the first shock, and a high wind of almost tornado velocity quickly sprang up. The loss of life, chiefly from the fire, amounted to about 100,000. Relief was rushed from all over the world. The Japanese authorities proceeded at once to the task of reconstruction.

EARTH ROADS, are dry weather roads, as they may become either soft and miry or dangerously slippery during rainy seasons. In their simplest form earth roads are merely a designated track without grading or shaping; an "improved" earth road is graded to produce a fair "profile," and "crowned" so that in cross-section the travelled surface is rounded and sheds water. On each side are ditches sufficiently deep to carry away storm water and permit the draining out of wet and unstable portions of the "subsoil."

When shaped and dry, they have satisfactory riding qualities and can carry moderate traffic without expensive maintenance. They require reshaping after each wetting to remove ruts. Where the traffic is considerable, the slope is maintained by use of a heavy drag or more effectively by a blade grader. Under heavy traffic maintenance is excessive and it is more economical to construct an all weather surface. *See also PAVEMENT SUBGRADES; OILED ROADS; GRADING MACHINES.*

EARTHSTAR, the name given to a genus (*Geaster*) of fleshy fungi closely allied to the puffballs. They are bulb-shaped or globose plants, usually brown or reddish-brown in color. The plant body is surrounded by a thickish wall composed of two or three layers enclosing the fruiting or spore-producing structures. When mature the outer wall splits into several regular, pointed segments. These segments unfold in a starlike fashion around the central fruiting body, which lies at the surface of the ground, whence the name earthstar.



EARTHWORM EGGS

EARTHWORM, the popular name for members of an order (*Megadrili*) of annelid worms, of which there are over 1,000 species, distributed almost all over the world. In most places they are very common but they do not live close to salt water, and they are rare in very wet or very dry regions.

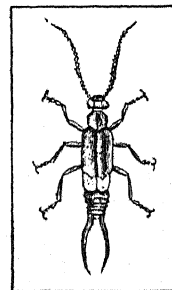
As their name suggests, most of them live in the ground, where they dig burrows. A few, however, are found in fresh water, and one form lives in trees. The majority are from 2 to 10 in. in length, but one species reaches 7 ft. They have elongate, slender bodies, divided into little rings or segments, each of which bears eight or more small rod-like or bristle-like projections, known as setæ, which serve for feet. All of them are hermaphrodites. Their eggs are deposited in curious cocoons, which encircle

the parent's body, and eventually pass off over the head.

Common earthworms have been called the most important of all animals. This is due to the fact that they plough and enrich the soil on a scale which makes man's best cultivating methods seem insignificant. The worms pass earth from underground through their bodies for the sake of minute organic particles which it contains, and during the night they void it upon the surface of the ground. In going through the worm's body earth is ground into very tiny particles, and mixed with digestive and vegetable juice. Thus the soil brought up by earthworms is of the finest quality. They also drag leaves into their burrows, where many remain to make excellent fertilizer.

An idea of the vast amount of work done by earthworms may be obtained from Charles Darwin's estimations, based on extensive experiments. He found that the worms bring up, annually, seven tons of new soil for every average acre of land. In good garden soil he discovered there are about 53,000 worms per acre; in fields there are about half that number.

EARWIG, a slender nocturnal insect of the order *Dermaptera*. The body is elongate, flattened, and possessed of a characteristic pair of strong movable forceps at the tip of the abdomen. These insects resemble rove-beetles (*Staphylinidæ*) in having short thickened forewings. They are usually found on the ground under stones, leaves or dead logs. Some species feed on decayed or living plant material. Others are predaceous on small insects.

EARWIG
Forficula sp.

EASEMENT, a right one land-owner has to use, for a specified purpose and in certain ways the land of another. Examples are the right to cut hay, the right to fish, or the right to walk or drive through certain defined paths or roads on the other's property. Certain easements are assignable and with the land, being mentioned in all conveyances (*see CONVEYANCING*). Others are not assignable.

EAST. *See FAR EAST; NEAR EAST.*

EAST ANGLIA. One of the Anglo-Saxon kingdoms of the so-called Heptarchy, including the counties of Norfolk and Suffolk. It was probably organized in the first half of the 6th century and reached the height of its influence about a century later. According to the historian Bede, the East Anglian king, Raedwald, succeeded Ethelbert of Kent as chief king in England. His supremacy was probably shadowy and was certainly short-lived, for he died in 618, only two years after Ethelbert's death. When about the year 880 England was divided between Alfred of Wessex and the Danes, East Anglia was part of the territory taken by the Danish king, Guthrum. It was recovered in the first quarter of the 10th century by Edward the Elder, who united into one kingdom all England south of the Humber River.

EAST AURORA, a village in Erie Co., western New York, situated 17 mi. southeast of Buffalo. It is served by the Pennsylvania Railroad and by motor bus lines. The region is good truck farming country, and farm implements and metal products are manufactured. **ELBERT HUBBARD** founded the Roycraft press and craft shops here. Pop. 1920, 3,703; 1930, 4,815.

EASTBOURNE, a watering-place and municipal borough of Sussex, England, on the English Channel coast, about 65 mi. southeast of London. A resort only since the middle of the 19th century, Eastbourne is divided into two parts, the old town inland where are the fine transitional Norman parish Church of St. Mary and the quaint old Lamb's Inn with its Early English vaulted crypt; and on the shore the modern resort of Eastbourne where a terraced, marine parade supplements a pier and pavilion, extensive parks, recreation grounds, art galleries and other buildings of a generally pleasant, well-planned town. Three miles to the southwest and once a refuge of smugglers, to-day a landing place for the Anglo-French cable, is Beachy Head where the South Downs rise abruptly sheer from the sea. Pop. 1921, 62,028; 1931, 57,435.

EAST CHICAGO, a port city in Lake Co., northwestern Indiana, situated on Lake Michigan, 23 mi. southeast of Chicago. It is served by bus and truck lines, lake steamers and several railroads. The chief manufactures are iron, steel and oil products, chemicals and railroads cars. The factory output, 1927, was worth \$171,396,513. Local retail business, 1929, was valued at \$16,382,522. The commerce of Indiana Harbor, which belongs to the city, amounted to \$70,836,212 in 1929. East Chicago was incorporated as a city in 1893. Pop. 1920, 35,967; 1930, 54,784.

EAST CLEVELAND, a city in Cuyahoga Co., northeastern Ohio. It is situated on Lake Erie, adjoining Cleveland on the east. Bus and truck lines and the New York Central and St. Louis railroads serve the city. East Cleveland is a residential community with some manufacturing. The total factory output for 1929 was worth about \$19,000,000; the retail trade amounted approximately to \$11,770,000. East Cleveland was incorporated as a village in 1895; it became a city in 1911. Pop. 1920, 27,292; 1930, 39,667.

EAST DETROIT, a city in Macomb Co., Michigan, situated as a suburb of Detroit. It is served by bus lines and an electric railroad. Farming is the leading interest of the community. East Detroit was incorporated as the village of Halfway in 1924; incorporated as a city under the present name in 1929. Pop. 1920, 500; 1930, 5,955.

EASTER, generally known to-day as the festival of Christ's resurrection. In the past, however, it has been associated with at least two other religious celebrations held at the same season, namely, the Jewish Passover and the pagan Anglo-Saxon celebration of the goddess of light or spring, Eostre, from whose

name the English word Easter is derived. The New Testament and the early Fathers of the Church fail to indicate the existence of any celebration of the resurrection at this season. The churches of the 2nd and 3rd centuries disputed long the exact day on which the event should be commemorated, those of Jewish descent holding that the Passover should determine the date, and the Gentiles insisting that the day of the crucifixion was the important factor. The Council of Nicaea (325 A.D.) settled the dispute by adopting the rule now acknowledged, that Easter should be the first Sunday after the full moon which happens upon, or next after, March 21, and that when the full moon happens upon a Sunday, Easter Day shall be the Sunday after. This sometimes brings Easter Day as early as Mar. 22, and as late as Apr. 25. The dates of all movable church feasts are determined by the date of Easter, since it is the central and most important feast of the year. Until the 7th century the churches of Rome and Britain observed different days, due to different methods of reckoning. The Eastern churches still adhere to the old calendar, which brings the day either before or after the day observed by the Western churches. Efforts have been made in recent years, through the English Parliament and the various European governments now working through the League of Nations, to secure a fixed Easter, the choice being the second Sunday of April, but without any present agreement.

EASTER ISLAND, also Rapanui and Te Pito te Huená, an island of the South Pacific Ocean, lying about 2,300 mi. from Chile, to which it belongs. It is a small island, covering an area of about 50 sq. mi. Interest in it is chiefly archaeological, since the island contains a remarkably large number of stone monuments and wooden tablets with strange inscriptions on them. The stone remains include, besides the monuments, cisterns, implements, towers, fish hooks and other objects. Among the monuments the most remarkable are the burial platforms, or *ahu*, which are surmounted by statues. Archaeologists believe that these remains are the work of the ancestors of the present inhabitants. However, attempts at interpreting the inscriptions have been fruitless. Pop. about 6,000.

EASTERN ORTHODOX CHURCH, THE, known also as the Greek Orthodox Church, is officially called the Holy Orthodox Catholic Apostolic Eastern Church, and claims to be the true successor of the early undivided Christian church. The term Eastern distinguishes it from the Latin or Roman Western Church, and the term Orthodox emphasizes its belief that it alone of all churches has retained and teaches the correct primitive Christian doctrines.

The Eastern Orthodox Church became estranged from the Western Church, so-called, over the question of papal supremacy and the doctrine of the *filioque*. The rupture threatened from the 5th to the 11th century, because of a difference in opinion on the doctrine of the *filioque*, which concerned the wording of a passage in the Nicene Creed. After

the words "and in the Holy Ghost who proceedeth from the Father," the Roman or Western Church added the words "and the Son," this addition never being accepted by the Eastern Orthodox Church. The break was definitely made in 1054, when Pope Leo IX denounced Michael Cerularius, patriarch of Constantinople, and his followers. Some students of history see in the break the logical issue of the political division between Byzantium and Rome, believing that Constantinople, inheriting a theological system based on Greek philosophy, which made correct interpretation of the doctrine of the Godhead important, could not long remain united with the Western Church which was strongly influenced by Rome and its legal past, which stressed practical human points.

Distinguishing Characteristics. The principal elements distinguishing the Holy Orthodox Catholic Apostolic Eastern Church are that it accepts the decisions of only the first seven ecumenical councils of the Church, which fact causes the Roman Church to treat it as schismatic rather than heretical; it baptizes infants by trine immersion, and it administers the sacrament in both kinds, using leavened bread; it permits its married men to be ordained to the priesthood and keep their wives afterwards, but selects its bishops from the celibate clergy only; in its elaborate ritual, it venerates relics and ikons, but forbids the use of carved images; uses the Greek scriptures, but, unlike the Roman Church, which keeps Latin as the ecclesiastical language, permits its national churches to conduct the services in their own tongues and the translation of the Bible in other languages; it bases the table of its church festivals on the Julian calendar, believing it to have an ecclesiastical sanction which cannot be changed by political enactment.

The Eastern Church has no later creeds in the sense understood by the Western Church; but its doctrines are set forth in certain confessions which are widely accepted, the principal ones being the Catechism of Moghilas, confirmed by the Eastern patriarchs and the Synod of Jerusalem in 1643, the Confession of Dositheus of 1672, and in Russia, the Catechism of Philaret. In brief, it can be said that in addition to its faith that the Holy Ghost proceeds from the Father alone, the Eastern Church venerates Mary as the Mother of God and honors nine orders of angels and the saints, but does not accept the doctrine of the immaculate conception of the Virgin Mary, as does the Roman Church, and rejects the doctrine of indulgences. It accepts six sacraments: baptism, communion, penance, priesthood, marriage and holy unction. The sacrament of anointing is administered at the same time as that of baptism, with chrism or holy oil. The doctrine of transubstantiation is accepted, and the Eucharist is given after confession and absolution. Holy unction is administered to the sick as well as to the healthy ones and not only to those in danger of death. The doctrine of purgatory is rejected; but the Church believes that prayers for the dead by the living are beneficial.

To-day the Eastern Church has within its fold ap-

proximately 120,000,000 believers, most of whom are in the membership of the Russian Orthodox Church, which since the war of 1914-18 has lost about 3,000,000 members to Poland and a smaller number to Lithuania and other old Russian provinces which have become politically independent.

Constituent Churches. The self-governing churches which constitute the Eastern Church are as follows: (1) the Ecumenical Patriarchate of Constantinople, (2) the Patriarchate of Alexandria, (3) the Patriarchate of Antioch, (4) the Patriarchate of Jerusalem, (5) the Archiepiscopate of Cyprus, (6) the Russian Church, which before the establishment of the Russian empire was nominally subordinate to Constantinople, and became in 1721 the Holy Synod with headquarters at Petrograd, (7) the Hellenic Church, or Metropolitanate of Athens, (8) the Metropolitanate of Carlowitz, in old Austria-Hungary, (9) the Church of Rumania, (10) the Serbian Church, now Yugoslavian, (11) the Archiepiscopate of Montenegro, (12) the Metropolitanate of Hermannstadt in Transylvania, (13) the Metropolitanate of Bukowina and Dalmatia, (14) the Holy Monastery of Sinai whose archbishop as such is attached to the Patriarchate of Jerusalem, but who as Abbot is independent, and (15) the Bulgarian Church, which, before the political independence of the country, was, through an exarch, under the Patriarchate of Constantinople. The effect of the Russian revolution on the Church in Soviet Russia, has doubtless been to reduce considerably the outward or professed membership; but the extent of the decrease cannot at this time be determined. Each of these churches stands in full communion with every other, and unites as an equal in a great federation; the five highest in precedence, not supremacy, are the Patriarchates of Constantinople, Alexandria, Antioch and Jerusalem. Nevertheless, for every question arising among Orthodox bodies, they refer for guidance to the Ecumenical Patriarchate of Constantinople.

The ecclesiastical preeminence of Constantinople came as the result of its political distinction when it became the imperial residence under the ancient empire. Originally, Byzantium was an episcopal see, subject to the Metropolitanate of Heraclea; but its rank grew with the rising importance of the city, so that, by the end of the 4th century, when a council of the Church was held there in 381, it is referred to in a canon as "the new Rome."

The United States. The Eastern Orthodox in America is represented by seven of the national churches known in Europe and Asia, namely, the Albanian, Bulgarian, Greek or Hellenic, Rumanian, Russian, Serbian, and Syrian Orthodox churches. The strongest in membership are the Russian and Hellenic, and the Albanians and the Rumanians are the smallest. The membership of the seven groups combined is approximately 2,000,000, representing about 1,000 churches. The churches of Albania, Bulgaria and Rumania were reported for the first time in the United States Census of Religious Bodies in 1916. The Hellenic Church is active in 34 states, with its strongest

memberships in New York, Illinois, Massachusetts and Pennsylvania, where the Greeks are most numerous. The Russian Church first started in Alaska in the 18th century and is active to-day in 15 states, the largest memberships being in Pennsylvania, New York, New Jersey and Connecticut. The Serbian Church is most active in Pennsylvania and Indiana, and the Syrian Church is largest in Massachusetts, New York and Pennsylvania. With the decrease of immigration from the countries of the Eastern churches, the increase which annually appeared up until 1920 has been less in evidence.

EASTERN QUESTION, an international question that has perplexed European statesmen for a century and a half. It arose through the conquest of the Balkan peninsula by the Turks, and the imposing of their yoke on millions of Christians. Added to this is the geographic fact that Constantinople and the Straits command the communications of Russia with the Mediterranean, and to a considerable extent those between western Europe and the Far East by way of the Mediterranean. Hence, Great Britain became almost as deeply concerned in the Near East during the last century as did Russia. About the beginning of the present century, the ambitions of Germany in the Near East, concretely manifested in the Bagdad Railway project, also appeared, and, with the interests of Austria-Hungary, added another serious international factor to the complicated Eastern Question.

Since the **TREATY OF KUTCHUCK-KAINARDJI** in 1774, when Russia first established a claim to a sort of protectorate over the Orthodox Christians of Turkey, there have been half a dozen wars over the Eastern Question as the subject races have one by one emerged from Turkish domination and been recognized as independent nations. During the World War the Allies agreed that Constantinople and the Straits area should go to Russia at the end of the war. But the Bolsheviks refused to stay in the war, and as a result the Paris Peace Conference tried to settle the Eastern Question by internationalizing the area, expelling the Turks from Europe and assigning all of their Asiatic lands except Asia Minor to themselves in the form of mandates. (*See SEVRES, TREATY OF.*) With the revival of Turkish Nationalism under Kemal Pasha's leadership, however, the Turks regained Eastern Thrace with Constantinople and Adrianople, their possession of it being confirmed by the treaties made at Lausanne in 1923.

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EASTERN STAR, ORDER OF THE, a beneficiary society restricted to immediate women relatives of Freemasons and such master MASONS as care to join, but not formally affiliated with Freemasonry. The present organization was formed in 1876 by Robert Macoy. The lodge officers are grand matron, grand secretary and grand treasurer. Local bodies are organized into state groups and the latter into a national

body, which annually elects a most worthy grand matron. Headquarters are at Washington, D.C. In 1930 the membership was approximately 2,005,601.

EASTHAMPTON, a town and village in Hampshire Co., southwestern Massachusetts. The village is situated on the Manhan River, 17 mi. northwest of Springfield and is served by the Boston and Maine and the New Haven railroads. Easthampton is a busy manufacturing center producing rubber elastic, cotton products, rayon, fireproof doors and various other commodities. The factory output of the town for 1927 was worth \$16,201,057. A factory for making cloth-covered buttons was built in 1848. Easthampton is the seat of Williston Academy, established in 1841. Sections of Northampton and Southampton were combined as Easthampton in 1785; the town was incorporated in 1809. Pop. 1920, 11,261; 1930, 11,323.

EAST HARTFORD, a town in Hartford Co., in north central Connecticut, situated on the Connecticut River, adjoining Hartford on the east, served by bus and truck lines and the New Haven Railroad. There is a private airport. East Hartford is an industrial center, manufacturing chiefly motors and bodies for airplanes, writing papers, furniture, pleasure boats and rubber stamps. Tobacco and market crops are produced in the vicinity. During the American Revolution Rochambeau's army encamped here. The city has an Indian burial ground. During the days of the Yankee Privateers anchors for ships were made in Burnside, a part of East Hartford. The town was founded about 1633; incorporated in 1783. Pop. 1920, 11,648; 1930, 17,125.

EAST INDIA COMPANY, a British chartered organization formed at the close of the 16th century to promote trade with India and neighboring countries and islands. In the 17th and 18th centuries East India companies, operating under Government franchises, were launched by Holland, France, Denmark, Scotland, Spain, Austria and Sweden with varying success. By 1700 the British East India Co. had obtained predominance, though the Dutch East India Co. continued to flourish for some time. Thenceforth the growth of the company, which had the status of a semi-governmental trading agency, was generally synonymous with the expansion of the British Empire in the East. In return for its franchises the company made the Government a series of loans: in 1708 the amount was \$16,000,000, in 1783 the sum was \$5,000,000. So great was the power of the company in India, where it rapidly increased its territorial holdings, that a regulating act was passed by Parliament in 1773 under which appointments of company governors in India required the approval of the Crown. The India and China trade monopolies were abolished in 1813 and 1833 respectively, and the company became largely an administrative body. After the Indian Mutiny of 1857 these administrative functions were assumed by the Crown, and in 1874 the company was dissolved.

EAST INDIES, a collective name once applied in a broad sense to the whole of India and the MALAY

ARCHIPELAGO but now restricted to the latter alone. Most of the islands belong to the Netherlands and are known as the DUTCH EAST INDIES. Borneo, Sumatra, Java and New Guinea are the largest islands of the group. There are several archipelagos, chief among which are the Moluccas, the Celebes and the Timor. Of the million square miles of territory which the East Indies embrace, 700,000 belong to Holland and of the 60,000,000 inhabitants 53,000,000 are under the Dutch flag.

EASTLAKE, SIR CHARLES LOCK (1793-1865), English painter and author, was born at Plymouth, Nov. 17, 1793. In youth he received inspiration from Benjamin Haydon and studied at the Royal Academy School. His first picture was exhibited when he was 20 years old. He lived in Rome from 1817-30 and painted there. Returning to England, he became a member of the Royal Academy in 1830, and in 1850 became its president and was knighted; among other honors, he was made director of the National Gallery in 1855. Eastlake's publications include a translation of Goethe's *Theory of Colors*, published 1840; *Materials for a History of Oil Painting*, 1847, and *Contributions to the Literature of the Fine Arts*, 1848. The painter died at Pisa, Dec. 24, 1865.

EAST LANSING, a town in Ingham Co., southern Michigan. It is situated on the Red Cedar River, adjoining Lansing, Mich., with which it is connected by street cars. It is the seat of the Michigan State College of Agriculture, founded in 1857. East Lansing was incorporated in 1907. Pop. 1920, 1,889; 1930, 4,389.

EAST LIVERPOOL, a city of eastern Ohio, in Columbiana Co., on the Ohio river, about halfway between Youngstown, O., and Wheeling, W. Va. The Pennsylvania Railroad and bus lines afford transportation to the city, which also has bridge and steamboat connections and a commercial airport 5 mi. to the northwest. It is traversed by Federal Highway 30. Natural gas occurs in the vicinity. The abundance and quality of potters' clay in the locality gave rise in 1839 to the industry which later made East Liverpool the principal white ware center of the country, although to-day all but one of the plants bring their raw material from outside sources. Tableware, tile, porcelain, rubber tires and electrical accessories are the principal products. In 1929 the approximate value of manufactures was \$9,000,000; the retail trade amounted to \$14,307,736. The original settlement was called St. Clair and was also known as Fawcettstown. In 1816 it was renamed Liverpool, and, when incorporated in 1834, became East Liverpool. John Hunt Morgan, Confederate general, was captured between Lisbon and East Liverpool, July, 1863. Pop. 1920, 21,411; 1930, 23,329.

EASTMAN, GEORGE (1854-1932), American inventor and philanthropist, was born at Waterville, N.Y., July 12, 1854. While a student in the public schools of Rochester, N.Y., he made amateur experiments in photography. In 1880 he began the manufacture of dry-plates, and in 1884 produced the first

photographic roll-film. Four years later he invented the "Kodak." He organized at Rochester the Eastman Kodak Company. During his life Eastman gave away more than \$75,000,000 of his fortune to educational institutions, among them the University of Rochester, the Eastman School of Music (Rochester), Massachusetts Institute of Technology, and the Hampton and Tuskegee Institutes. He also donated large sums to raise health standards in the United States and Europe. For many years he advocated the adoption of a thirteen-month calendar. He visited British East Africa in 1927 where he photographed many scenes of wild animal life. In 1928 his company announced the perfection of a process of color-photography, reproducing all the colors of the spectrum in both stills and motion pictures. He donated \$1,000,000 in 1930 for a child dental-clinic in Paris, and established similar clinics in London and Rome. Following a long period of ill-health, Eastman ended his life, Mar. 14, 1932.

EAST MOLINE, a city in northwestern Illinois, in Rock Island Co., situated on the Mississippi River, adjoining the city of Moline. It is served by several railroads. The city lies in a good farming region. The chief manufactures are ploughs and farming machinery, scales, engines, pressed steel and toys. In 1929 the retail trade amounted to \$2,906,122. East Moline was incorporated in 1907. Pop. 1920, 8,675; 1930, 10,107.

EASTON, a city in eastern Pennsylvania, the county seat of Northampton Co., on the Lehigh Canal and forks of the Delaware and the Lehigh rivers, 73 mi. southwest of New York City. Buses, coal barges and five railroads afford transportation. Easton is a trade center for a fertile agricultural district, the chief crops of which are corn, small grain, apples and peaches. Adequate hydro-electric power is available. The city has many factories, producing heavy machinery, pumps, compressors, chemicals, cement and slate. The manufactured output, 1929, was valued at \$23,371,697. In 1929 the retail business reached a total of \$27,616,342. Easton is the seat of Lafayette College, opened in 1832 and named for Gen. Lafayette. The city was laid out in 1750 on an Indian trading post by William Parsons, under the direction of Thomas Penn. Easton was incorporated as a borough in 1789 and as a city in 1887. The old Reformed Church, built in 1776, in which several treaties were signed with the Indians, was used as a hospital during the American Revolution. The home of George Taylor, signer of the Declaration of Independence, is in Easton. Pop. 1920, 32,813; 1930, 34,468.

EAST ORANGE, a city of Essex Co., N.J., located 12 mi. west of New York City and adjoining Newark on the west. It is served by the Erie and Lackawanna railroads, trolleys, and motor bus lines. East Orange is mainly a residential community and is the seat of Upsala College, founded in 1893, Panzer College and the Baptist International Seminary. Its industries include the manufacture of electrical equipment, hydrants, airplane parts and pharmaceuticals. In 1929

the factory output reached approximately \$12,000,000; the retail trade amounted to \$29,932,299. Near what is now the business center of the city was located one of the first copper mines worked in the United States, first used in 1720. East Orange was incorporated as a separate township in 1863 and received its charter as a city in 1899. Pop. 1920, 50,710; 1930, 68,020.

EAST PALESTINE, a city in eastern Ohio, in Columbiana Co., situated 18 mi. north of East Liverpool, O., and served by the Pennsylvania Railroad. The surrounding region is fine fruit-growing country and has coal, oil shales and fire clay deposits. The manufactures are pottery wares, automobile tires, steel tanks, electrical devices and various other commodities. Pop. 1920, 5,750; 1930, 5,215.

EAST PEORIA, a city in Tazewell Co., north central Illinois, on the Illinois River, immediately east of Peoria. It is served by three railroads. The city is in a coal-mining region. The chief manufactures are paint, traction engines, farm machinery and washing machines. Fruit and farm crops are raised in the vicinity. Near by is Ft. Creve Coeur, built by La Salle in 1680. Pop. 1920, 2,214; 1930, 5,027.

EAST PITTSBURGH, a borough in southwestern Pennsylvania, in Allegheny Co., situated on the Monongahela River, 12 mi. southeast of Pittsburgh; served by four railroads. The city has electrical apparatus factories and dairy product industries. In the vicinity the French and Indian forces defeated General BRADDOCK in 1755. East Pittsburgh was settled in 1871 and incorporated in 1895. Pop. 1920, 6,527; 1930, 6,214.

EAST POINT, a city about 5 mi. from Atlanta, in Fulton Co., northwestern Georgia. The Atlanta and West Point and the Central of Georgia railroads and the Georgia Power Street Car Lines serve the city. Cotton, corn and dairy products are abundant in the surrounding region. Productive mica deposits are found near by. East Point is a residential and industrial city, with 21 factories manufacturing about 75 different products. East Point was incorporated in 1887. Pop. 1920, 5,241; 1930, 9,512.

EASTPORT, a port city on Moose Island, in Passamaquoddy Bay, off the coast of Maine. It is situated in Washington Co., 25 mi. southeast of Calais and is served by ferries, steamships and the Maine Central and Canadian Pacific railroads. Eastport is the most eastern city in the United States, a gateway to Maine's hunting and fishing grounds and an important fishing and sardine-canning center. The tide rises and falls 28 ft. on the coast. Moose Island was discovered by Champlain and De Monts in 1604, and tradition says that the Norsemen visited here. The city was settled in 1760 and incorporated in 1893. The British captured the island during the War of 1812 and held it for four years. Pop. 1920, 4,494; 1930, 3,466.

EAST PROVIDENCE, a town of eastern Rhode Island on the east side of the Seekonk and Providence rivers opposite and 2 mi. east of Providence. It is served by the New Haven Railroad and motor bus

lines. The chief industries of East Providence are the extensive shipping of oysters, the manufacture of wire, and dyeing and bleaching. The city is an important oil distributing center. In 1929 the value of manufactures was about \$13,000,000; the retail trade was \$7,879,611. Pop. 1920, 21,793; 1930, 29,995.

EAST RIVER, a strait in New York which separates Manhattan and the Bronx on the west and north from Brooklyn and Queens on the east and south, and connects New York Bay with Long Island Sound. It also connects with the Hudson River, via the Harlem River and Spuyten Duyvil Creek. It is about 15 mi. long, with a maximum width of 3½ mi., and is navigable for large vessels throughout its length. Its islands, which contain city institutions, are Welfare, Ward's, Randall's, Riker's and North Brother.

EAST ROCHESTER, a suburb situated 7 mi. southeast of Rochester, in Monroe Co., western New York. It is served by the New York Central Railroad. Local manufactures include refrigerator cars, pianos, drills, brassware, grain and paste. The agricultural interests of this region are dairying, poultry raising and fruit-growing. Pop. 1920, 3,991; 1930, 6,027.

EAST RUTHERFORD, a borough of Bergen Co., N.J., situated 8 mi. west of New York City and adjoining Rutherford and Carlstadt, N.J. It is served by the Erie and the New Jersey and New York railroads and numerous bus lines. Its various industrial establishments include nurseries, oil distribution depots, bleacheries, and plants producing roofing, saws, textiles, hats and perfumes. It was incorporated as a town in 1894. Pop. 1920, 5,463; 1930, 7,080.

EAST ST. LOUIS, a city of southwestern Illinois, in St. Clair Co., on the east bank of the Mississippi River opposite St. Louis, Mo. Upwards of 20 railroads serve the city, which in 1929 was the fourth industrial center in the state. Its various manufactures, including establishments beyond the corporate limits, comprise meat-packing plants, iron, steel, chemical, glass, and aluminum works, flour-mills, and baking-powder factories. In 1929 the factory output was valued approximately at \$88,000,000; the retail trade amounted to \$33,100,075. The industries benefit from extensive coal-mining in the county. The city has large stockyards and is a leading horse and mule market. Cahokia Mounds State Park, immediately north of the city, contains the prehistoric "Great Cahokia" or "Monks" mound, and a large collection of Indian relics. The village of Cahokia just south of the city was an early French settlement dating from 1682, where Pontiac, noted chief of the Ottawa Indians, was slain in 1796. The city of East St. Louis was founded in 1797 by Capt. James Piggott and was chartered in 1865. Pop. 1920, 66,767; 1930, 74,347.

EAST STROUDSBURG, a borough in Monroe Co., in eastern Pennsylvania, situated 30 mi. north of Easton, on the Delaware River; served by two railroads and bus lines. The railroad name of the borough is Stroudsburg. It is in a farming region and has various manufactures, including structural steel, boilers, tannery products and silk. It is a summer

resort surrounded by the Kittatinny and Pocono mountains. It is the seat of a State Teachers College. Pop. 1920, 4,855; 1930, 6,099.

EASTVIEW, a town of Russell Co., Ontario, Canada, situated on the Ottawa River, 1 mi. east of Ottawa. Eastview is served by the Canadian National Railway. The town is a pleasant residential suburb of Ottawa, with several manufacturing plants including flour, feed and saw mills, and sash and door factories. Pop. 1921, 5,324; 1931, 6,686.

EAST WINDSOR, an international border city, in Essex Co., Ontario, Canada. It adjoins Windsor and Walkerville across the Detroit River from Detroit, Mich., and is served by four railroads. Automobiles and forgings are manufactured. The city is surrounded by a region devoted to mixed farming in which peach and tobacco cultivation predominate. It is the seat of the Canadian Ford Automobile Company. Pop. 1921, 5,870; 1931, 14,241.

EATON, TIMOTHY (1835-1907), Canadian merchant, was born in Clogher, Ireland, in Oct. 1835. At an early age he was apprenticed to a draper and upon the completion of his term of service emigrated in 1857 to Canada. There he engaged in retail trade, first at Kirkton, later at St. Mary's, and finally at Toronto where, in 1869, he established the department store which bears his name. Eaton was eminently successful as a merchant and increased his business into one of the largest stores in America. He died in Toronto, Canada, Jan. 31, 1907.

EATON, WYATT (1849-96), American painter, was born at Philipsburg, Canada, May 6, 1849. He studied at the National Academy of Design, New York, and at the École des Beaux-Arts, Paris, under Gérôme. In 1877 he opened a studio in New York, painting portraits and landscapes with figures. He taught at Cooper Institute and helped to found the Society of American Artists. His portraits of the poets Emerson, Whittier, Longfellow, Bryant, Holmes and Dr. Holland, engraved by T. Cole for *Century Magazine*, were considered an innovation in magazine work. Among Eaton's works are portraits of Bishop Horatio Potter, Roswell Smith, President Garfield and John Burroughs. The artist died at Newport, R.I., June 7, 1896.

EAU CLAIRE, a city in western Wisconsin, the county seat of Eau Claire Co., situated at the confluence of the Chippewa and Eau Claire rivers, 89 mi. east of St. Paul, Minn. Three railroads afford transportation. The rivers furnish ample water power. Eau Claire manufactures chiefly paper, lumber and lumber products, wood pulp, machine tools, rubber goods, canned products, refrigerators and shoes. In 1929 the factory output reached an approximate total of \$23,000,000; the retail trade amounted to \$16,213,641. A State Teachers College is located here, also a State Fish Hatchery. Eau Claire was founded about 1847, and owed its early rapid growth to the lumber trade; it was chartered as a city in 1872. In 1881 the State Militia was summoned here

during a serious strike. Pop. 1920, 20,906; 1930, 26,287.

EBERS, GEORG MORITZ (1837-98), German Egyptologist and novelist, was born Mar. 1, 1837 in Berlin. He studied archaeology and Oriental languages at Berlin and jurisprudence at Göttingen. After extended scientific expeditions to Egypt Ebers became professor of Egyptology at Leipzig. To demonstrate his idea of popularizing this subject through historical romances, he wrote *An Egyptian Princess*, 1864, *Uarda*, 1877, and other novels and books including *Egypt and the Books of Moses*, 1868; *Through Goshen to Sinai*, 1872, and *The Burgomaster's Wife*, 1882. He died at Tutzing, Bavaria, Aug. 7, 1898.

EBERSWALDE, a German city about 30 mi. northeast of Berlin. It has a Gothic church of the 14th century, a rathaus of 1775, the remains of old city walls, many schools, including the Prussian State Academy of Forestry, iron foundries, railway repair yards, saw mills and brick yards. In 1913, one of the greatest prehistorical gold treasures was found near Eberswalde, consisting of finished and partly finished objects, drinking cups and ornaments and pure metal, attributed to the Early Bronze Period (1050-850 B.C.), now in the Prehistoric Museum, Berlin. Pop. 1925, 29,570.

EBERT, FRIEDRICH (1870-1925), first President of the German Republic (*see* GERMANY, HISTORY OF), was born in Heidelberg Nov. 4, 1870. He became influential in the ranks of the Socialist party of Germany and was elected to the Reichstag in 1912. When the Kaiser abdicated, Nov. 1918, Herr Ebert became the leader of the forces of law and order and on Feb. 11, 1919 he was elected by the Weimar Assembly President of the newly-proclaimed German Republic. On Aug. 21 he took the oath of office under the constitution as President, an office he held until his death at Charlottenburg, Feb. 28, 1925.

EBIONITES, a Jewish Christian sect of unknown origin which flourished from the 2nd to the 4th centuries of the Christian Era. No such person as Ebion, their alleged founder, ever existed. The early Christians at Jerusalem, as is asserted by Origen, were originally called Ebionim, or the poor (cf. Galatians 2:10) because of their extreme and intentional poverty, which they endured willingly, in accordance with Jesus's teachings. It is not known for certain whether the name Ebionites was given to them by those who had not become members of the group, or had been adopted by the members of the sect themselves.

When the term Christians attained to general acceptance, the Jewish Christians were known as Ebionites. Subsequently the Jewish Christians were incorporated into the great masses of the pagan population which had been converted to Christianity; the term Ebionites then was employed as a designation for a heretical Jewish Christian sect which, while acknowledging the Messianic character of Jesus, none the less denied both his divinity and the virgin birth. This

heretical Jewish Christian sect further had its own Gospel, and adhered to the Jewish Law, which it regarded as so important that it demanded the observance of the Mosaic laws from Gentile Christians as well. It also required circumcision and the observance of the Sabbath on the seventh day of the week. The Ebionites considered Paul an apostate, and therefore rejected all his writings. In addition, its teachings included several Gnostic elements. These Ebionites abstained from meat, had only one white linen robe each, avoided the use of oil for the body and of superfluous garments, practiced celibacy, and managed the expenditures of their community by means of a board of seven appointed administrators. According to Eusebius, the Ebionites lived at Choba, to the north of Damascus, Syria, and Symmachus, the Greek Bible translator, was one of their number.

A. SH.

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EBONY (*Diospyros Ebenum*), a medium-sized tree, closely related to the persimmon, found in southern India and Ceylon. It produces a dense very black heart-wood, highly valued for cabinet work. Because of its hardness, durability, susceptibility to high polish and glossy black color, ebony is much employed for inlaying, for turnery, and for making musical instruments. The wood of *D. reticulata*, native to Mauritius, is scarcely less excellent. Various other species of *Diospyros* yield very similar woods used as ebony, including the persimmons (*D. virginiana* and *D. texana*), found in the southern United States.

EBRO, a large river of northeastern Spain, rising in the north central part of the peninsula, on the southern slopes of the Cantabrian Mountains. It winds toward the south for more than 450 mi. and flows into the Mediterranean beyond the city of Tortosa. The Ebro is supplied by over 29,000 sq. mi. of land. Its chief tributaries, the Aragon and Segre rivers, furnish a large volume of water which is utilized for the irrigation of Aragon. The San Carlos Canal has made navigation possible at the sand-obstructed mouth of the Ebro, but it is hindered by rapids and shoals along the course of the river. The Imperial Canal, from Tudela to beyond Zaragoza, has partly overcome these impediments. Zaragoza, Logroño, Tortosa and Caspe are the principal cities along the Ebro's banks.

EBURACUM, once the chief Roman settlement of England and now the city of York. It was the headquarters of the sixth Roman legion and the residence, when visiting Britain, of the Roman emperors, two of whom, Septimius Severus and Constantius Chlorus, died here. The city was made the seat of a Christian bishop in the 4th century, and in Ebor, the official title of the Archbishop of York, the name has been preserved. Some of the ancient Roman walls still survive in York.

EÇA DE QUEIROZ, JOSE MARIA (1843-1900), Portuguese novelist, was born at Pova du Barzim, Nov. 25, 1843. As a Consul his life was spent in

England, France and Cuba. His works, greatly influenced by the French, have been translated into many languages. *The Crime of Father Amaro*, 1875, is perhaps the best known. Eça de Queiroz died in Paris, Aug. 16, 1900.

ECCLESIA, the general assembly of the people at Athens, to whom all citizens of age were eligible, which discussed matters sent down to it by the *Boule* and also new matters originating within its own body. It declared war, made peace, ratified treaties, elected the generals, conducted the wars and managed the funds. Once a year it met in the *AGORA* in general session to vote on *OSTRACISM*.

ECCLESIASTES, BOOK OF, called also *The Preacher*, in the Old Testament, derives its name from the Greek word which translates the Hebrew word *Kohleth*, meaning a cleric or preacher. For many centuries the book was ascribed to Solomon, grown wise in his old age. Others have credited it to Isaiah or Hezekiah; but many modern scholars date its final form from about the 3rd century B.C., as reflecting intellectual contacts with other national philosophies that were known in the days of Solomon. The book has an apparent or real double teaching, which may or may not be due to different authorship. The first teaches that "all is vanity" and that the end of living is to eat, drink and enjoy good. The other stresses the wisdom of behavior based on "the fear of the Lord," as the regulating principle. Both may be the views of one writer blending Hebrew and Greek thought.

ECCLESIASTICAL CORPORATION, a corporation formed of one or more persons, for religious purposes. In Great Britain it is under the supervision of Ecclesiastical judications. In the U.S. it is a civil corporation created for religious purposes and regulated by civil courts.

ECCLESIASTICUS, BOOK OF, one of the apocryphal books of the Old Testament, which is included in the Catholic canon. It forms part of the Hebrew *Hokmah*, or Wisdom literature. The book claims to have been written by Jesus, the son of Sirach, about 200 B.C., and there seems to be no reason to doubt this. The loosely arranged aphorisms are adapted to almost every conceivable emergency in life, and the book was probably put together as a reference guide for daily conduct. It bears traces of Greek culture, but sets forth the superiority of Judaism over Hellenism, making Wisdom to depend on "the fear of the Lord," which means obedience to His laws.

ECHIDNA, a monotreme mammal of the family *Echidnidae*, called also spiny anteater. It is a small, short-legged creature about 15 in. long; clothed, except the head, in a mantle of heavy spines and hairs. Having powerful claws, it digs a burrow-home for itself, and at night creeps about excavating ant hills and catching the insects on its glutinous tongue. The female annually produces a single egg; she at once places this within a fold of the skin of her abdomen, where the egg soon hatches out and the young one suckles until grown. These anteaters abound in Aus-

tralia, and are a favorite food of the aborigines. A related form, the Nodiak, occurs in New Guinea.

ECHINOCOCCUS DISEASE. See PARASITIC DISEASES.

ECHINODERMS (Echinodermata), a numerous group (phylum) of marine invertebrates, constituting one of the major branches of the animal kingdom. There are about 4,000 species, which are comprised in five classes: (1) starfishes (Asteroidea), (2) brittle-stars (Ophiuroidea), (3) sea urchins (Echinoidea), (4) sea cucumbers (Holothuroidea), and (5) crinoids (Crinoidea). See also ZOOLOGY: Phylogenetic System.

ECHO, in Greek mythology, a mountain nymph or Oread, loved in vain by PAN. In revenge he made some shepherds tear her to pieces in frenzy, but they could not destroy her voice. Earth buried her body but allowed her voice to live. Ovid's version is that ZEUS employed her to talk to HERA to distract her attention from his intrigues. When the goddess discovered the deception she took away Echo's power of speech but made her repeat the last words of the speech of others.

ECHO, in acoustics. See ACOUSTICS OF BUILDINGS.

ECK, JOHANN MAIER (1486-1543), German theologian, the most capable adversary of MARTIN LUTHER, was born at Eck, Swabia, Nov. 15, 1486. While professor of theology at the University of Ingolstadt, he opposed Luther's religious opinions, and in 1519 was victorious in a debate with him at Leipzig. Eck visited Rome the following year and obtained the famous bull of excommunication against Luther. In 1530 he was among those selected to draw up articles refuting the Lutheran Confession of Faith at the Diet of Augsburg. He died at Ingolstadt, Feb. 10, 1543.

ECLAMPSIA, a disease which affects pregnant women. Since it is characterized chiefly by the occurrence of convulsions, the laity usually refers to this disease as "convulsions" or "fits." Other prominent symptoms are high blood pressure, swelling of the legs, hands and face, headaches, nausea, vomiting, pain in the upper part of the abdomen, blurred vision and disturbances in the function of the kidneys as determined by examination of the urine and blood. The cause of this disease is not definitely known, but it is assumed that some poison, the source of which is unknown, but probably due to the changes of pregnancy, circulates in the blood and produces all the symptoms. In the United States about 25,000 pregnant women have eclampsia each year and of this number about 5,000 die from the disease. About 50% of the babies of mothers with this affliction die before, during or shortly after birth. Almost all of these lives can be saved because eclampsia is one of the most easily preventable of all diseases. If all women were carefully and frequently examined by a physician throughout their entire pregnancy, eclampsia would be a rare disease. It recurs in subsequent pregnancies in about 5% of those who recover. A new pregnancy should not supervene until at least two years after an attack and then only provided the kidneys are entirely

normal. See also CHILDREN, DISEASES OF: Prenatal Diseases. J. P. G.

ECLECTICISM, a philosophical method closely associated with the Alexandrian school of the early Christian Era. The creative aspect of the Greek mind had run its course at this time, and but little originality was displayed by thinkers of the period. At Alexandria the East and the West met in an effort to reconcile their positions. The result was an eclecticism, a borrowing from a number of philosophical schools without a new distinctive unity. The thought of the period was a strange mixture of philosophy and theology. Philo tried to apply Greek philosophy to Judaism, while with PLOTINUS eclecticism issued in NEOPLATONISM, a combination of Christian doctrine and Greek metaphysics. The term has been extended to include any borrowing which represents a syncretism of a number of different philosophical positions.

ECLECTICISM, in medicine, appeared in Greece about the time of Hippocrates *circa* 320 B.C. Thus eclectics were a group who proposed to dispense with the Hippocratic and Galenic idea and who developed an independent school of scientific medicine. The second eclecticism began with Hufeland who, in 1795, opposed all systems of medicine. Since his time the science of medicine has been truly eclectic. A third eclecticism represents a medical sect devoted to the conception that there are plant remedies for specific conditions. Its founders include Samuel Thompson, born in New Hampshire in 1769, and Wooster Beach, born in Trumbull, Connecticut, in 1794. Various medical schools devoted to the eclectic system existed in the United States, beginning with the New York Medical Academy in 1837 and ending with the Eclectic Medical College in Cincinnati, Ohio, in 1929. M. F.

ECLECTICISM, in painting, a reversion to "old master traditions" by a group of able French painters who exhibited chiefly in the first 20 years of the 20th century. Weary of the novel technique as an end in itself, their aims were to present contemporary life by naturalistic observation, through the most perfect technique of all time, to impart a modern vital element to museum classicism. The group strove to unite human reality with ideal intentions. Their principles necessitated a stern discipline and a wide knowledge of popular and primitive technique in drawing and painting. The movement attracted artists of taste and intelligence who possessed great dexterity in line and color. While André Derain was the most powerful representative of this movement and had many followers, there was a natural tendency for each individual to be attracted by some particular old master, and through him to develop a personal style. Thus Friesz was drawn to Delacroix, Alix to Daumier, Favory to Rubens, and Modigliani created a style inspired by the Neo-Renaissance. Among other distinguished artists who later followed the so-called museum trend were Emil Besnard, Maurice Denis, K. X. Roussel, Dufrenoy and Odillon Redon. Eclecticism was also the guiding principle of the 16th-17th century BOLOGNESE SCHOOL OF PAINTING.

ECLIPSE, the total or partial hiding of the light of a heavenly body by another body or its shadow. Solar eclipses are due to the interposing of the moon between the sun and the earth; eclipses of the moon are caused by the earth's shadow cast on the moon. Solar eclipses may be total, the moon completely hiding the sun; partial, when the moon cuts only across a portion of the light of the sun; annular, when the moon, unusually distant from the earth, hides the center of the sun but leaves a ring of light at the edge. Lunar eclipses may be total or partial. Due to the refraction of the sun's rays, a lunar eclipse never completely obscures the moon from sight. Lunar eclipses occur only at full moon. Early history contains many records of eclipses, supernatural significance having been ascribed to them by primitive people. For a further discussion of eclipses see *ASTRONOMY*.

ECLIPSING BINARY, a **DOUBLE STAR**, so oriented in space that the one star, while revolving around the other may pass directly in front, as seen from the earth and eclipse some of the other star's light.

ECLIPTIC, the plane of the orbit in which the earth revolves around the sun, and in the sky the great circle which forms the intersection of this plane with the celestial sphere. It is inclined by an angle of $23\frac{1}{2}^{\circ}$ to the equator and marks the apparent course followed by the sun in the sky.

ÉCOLE DES BEAUX-ARTS. See *BEAUX-ARTS*, *ÉCOLE DES*.

ECOLOGY. Ecology is of relatively recent origin as a recognized subdivision of biology. The word comes from the Greek *oikos* meaning home, and, literally stated, ecology is the science concerned with the home life of organisms. Haeckel in 1869 coined the term as "Oekologie" and defined its content as "comprising the relation of the animal to its organic as well as its inorganic environment, particularly its friendly or hostile relations to those animals or plants with which it comes in contact." More precisely ecology is a phase of the science of biology which deals with the organism as a whole in relation to its complete natural environment; less precisely but more picturesquely it has been defined as "scientific natural history."

Buffon (1707-1788) called attention to the "bionomics" or interrelations of organisms. Geoffrey St. Hilaire clearly outlined the scope of such interrelationships in 1859 under the name of "Ethology." Semper in 1889 regarded this field as comprising the physiology of organisms in contrast with the more usually considered physiology of organs, and much of the field of modern ecology has been called simply "biology"; thus some investigators still speak of the biology of a snail or of a region rather than its ecology.

The subject matter of ecology was subdivided by Schröter (1896, 1902) into "autecology" or the ecological relations of the individual, and "synecology" or the similar relations of communities of organisms. Studies in the physiology of organisms, in natural his-

tory, and in specialized "biology" usually relate to autecology, while the distinctive contribution of ecology as an organized part of biology lies in its recognition of the existence of communities of plants and animals which can be treated as units. St. Hilaire (1859) suggested this idea; Kerner (1863) sketched the development of plant communities as units. Verrill (1874) described communities of animals based on habitat relationships and Forbes (1887) clearly outlined the organization of communities on the basis of mutual interests of the constituent plants and animals. Warming (1895) first called attention to the universality of orderly vegetational change, and Cowles in 1899 by his studies of the plant communities on the Indiana sand dunes laid the foundation for the dynamic presentation of the organization of communities which prevails in plant and animal studies to date. The application of these principles to animal communities was made by Adams and by Shelford in the first decade of the present century.

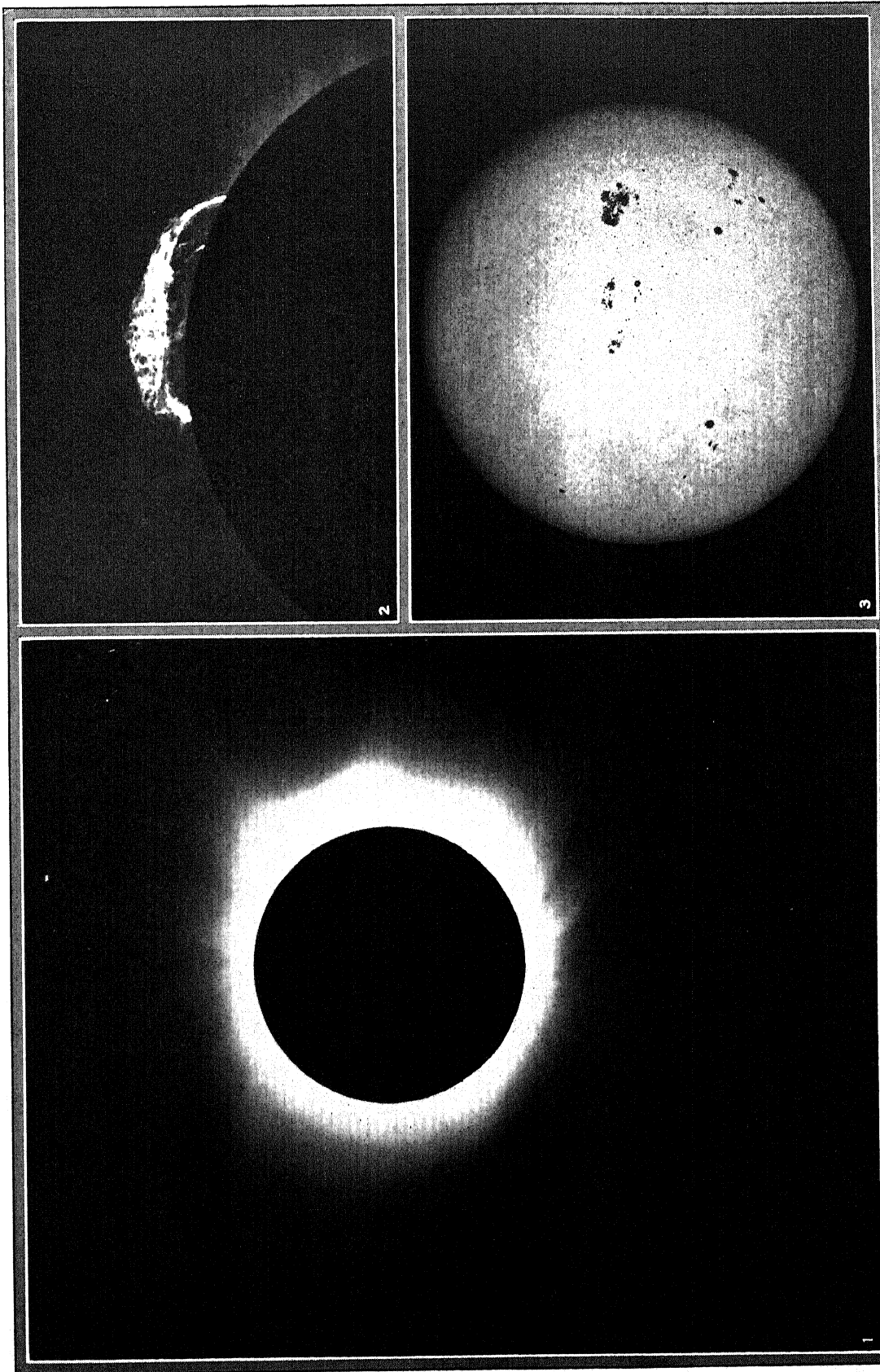
The growth of plant ecology was more rapid than that of animal ecology because of the much smaller number of plant species and because many of their environmental relationships are more obvious. The presence of a pine forest is apparent to the passerby but whether there is a community of animals in such a forest is a matter to be discovered only after careful researches. The nature of responses of animals and plants to environmental changes differs fundamentally. The former have relatively fixed structures but are plastic in behavior and are usually motile, while plants readily change their growth form under environmental influences but are mainly sessile, with small chance of exhibiting obvious behavior responses. For these reasons and because of the inherent complexity of the subject-matter of ecology, its early development as a science tended to emphasize the difference between plant and animal ecology. At present the essential unity of the subject is being recognized and there is an awakening of interest in the complete ecology designated by the term "biocology."

The primary problems of community studies are:

1. The organization, structure or composition of the community.
2. The interrelations of different communities with each other and with their environment.
3. The time relations of communities which center about their rise, development, succession and decline.
4. The geographic distribution of communities which is concerned with their arrangement in space over the face of the earth.
5. The classification of communities, which attempts the delimitation of different communities as social units, their grouping into units of higher orders and their systematic arrangement.

Much of the content of autecology overlaps other fields, particularly that of the physiology of organisms; and since the development of community studies is the distinctive contribution of modern ecology, there have been recurrent attempts to define ecology as the science of biotic communities. Such definitions

ECLIPSE



1, COURTESY OF THE VAN VLECK OBSERVATORY, MIDDLETOWN, CONN.; 2, ASTRONOMER ROYAL, GREENWICH OBSERVATORY; 3, THE MOUNT WILSON OBSERVATORY

PHOTOGRAPHIC OBSERVATIONS OF ECLIPSES OF THE SUN

1. Photograph of a total eclipse of the sun, Jan. 24, 1925, visible in many parts of the United States.
2. Great prominence recorded during the total eclipse of May 20, 1910, at Sobral, Brazil.
3. A direct image of the photosphere showing a large number of sun spots.

have always failed since it is necessary to understand the environmental relations of the constituent animals and plants in order to secure full information concerning the organization, interrelations, development, distribution and classifications of the communities themselves.

Ecology occupies a crossroads where biology meets many major sciences; notably those of physics, chemistry, geology, physiography, geography and meteorology. Citations to pertinent literature will be found in the articles on plant and on animal ecology.

H. C. C.; W. C. A.

PLANT ECOLOGY

Plant ecology is that division of biological science that has to do with the various interrelationships between plants and their environment. It has two major subdivisions, autecology and synecology, or plant sociology. Autecology treats of ecological relationships between the individual plant or its various organs and their surroundings; while synecology, or plant sociology, treats of the group relationships existing between plants in mass and their surroundings. Autecology deals with the ecological relationships of plant forms such as trees, shrubs and herbs, or plant organs such as roots, stems, leaves, flowers and fruits. As might be expected, plant ecology overlaps many other sciences. Autecology, for example, deals with the ecological relations of plant structure and behavior. In its treatment of structure it overlaps morphology and anatomy and in its behavior relations it overlaps physiology. The difference between autecology and these other fields is largely one of viewpoint. Morphology, anatomy and physiology are essentially laboratory sciences, concerned with what may be considered the normal or usual features of structure and behavior, whereas autecology is in the main a science of the field which endeavors to interpret the variations which plants show in their different field environments. The closeness of relationship to physiology is especially evident in experimental ecology, which, while largely an outdoor science, also, of necessity, involves laboratory and greenhouse investigations for the sake of more perfect control of the environmental factors than can be had in the open. Even here, however, there is the difference that ecology in its viewpoint concerns itself mainly with the influence of these factors in producing changes of structure and behavior and in the fact that the laboratory and greenhouse studies are carried on mainly for the purpose of more perfectly understanding what happens in the open, and why. Synecology, or plant sociology, treats mainly of plant groups which may be conveniently called plant communities, and considers their origin and development and their relations to the outside world, including, of course, the influence that may be exerted by plants upon each other. Synecology thus overlaps soil science and physiography and ecological plant geography overlaps geography and meteorology.

Environmental, or Ecological, Factors. There are a number of environmental factors that are abso-

lutely fundamental for successful plant life. The most important of these are light, temperature, water, oxygen, carbon dioxide, nitrogen salts, other soil salts, and other organisms. Of these some are almost always present in adequate amount, while others, especially water and the proper temperature, are often inadequately present, and hence limit the successful growth of plants. For this reason they may be called limiting or critical factors. In deserts, most plants are excluded because of the limited water supply. In the arctic regions most plants are excluded by reason of improper conditions of temperature.

By almost general consent the most important of all environmental factors is water. It is by and large the chief limiting factor involved in the successful growth and development of plants. The failure of an adequate water supply is a most important cause of plant disaster, not only in crop production but also in nature. Water is the chief factor in the development of plant communities. The great plant landscapes of the world, as worked out in ecological plant geography, such as rain forests, deciduous forests, prairies and deserts, are related chiefly to atmospheric water, that is, rainfall, humidity and evaporation. Local communities, such as those of ponds, swamps, sandy fields and rocks are related more to soil water than to anything else. The most widely used, and perhaps the most important classification of plant communities is one recognizing the importance of water relations, namely hydrophytes (water and swamp plants), xerophytes (plants of dry soil or climate) and mesophytes (plants of intermediate moisture relations); the adjectives corresponding to these terms are, respectively, hydric, xeric, and mesic.

A second factor of great importance is temperature, which is well known to be often a limiting factor in nature and in agriculture. This is recognized by the common division of the earth into frigid, temperate and tropical zones. It is well known that many plants are intolerant of frost and that other plants, though less sensitive, nevertheless succumb to temperatures below the freezing point. Even the most hardy plants commonly become inactive at or near the freezing point of water. However, many examples of behavior such as leaf-fall and winter killing, commonly related to temperature, are really in the last analysis due to water deficiency. The plants are dried out by evaporation, and the temperature is too low for further replacement of water from the cold or frozen soil.

Other Factors. Light, of course, is an absolute necessity for plant life. However, it is not often a limiting factor. The same may be said for oxygen, carbon dioxide and most soil salts. Probably the most common limiting factor other than water and temperature is the acidity or alkalinity of the soil. In soils that are extremely acid or extremely alkaline very few plants can grow successfully.

Experimental Autecology. This division of the science aims to put to experimental test the results of field observations. It has long been known, for

example, that most extreme hydrophytes have many common characteristics, such as smoothness of leaf surface, leaf thinness and dissection, absence of stomata, looseness of stem and leaf tissue. In contrast to these, extreme xerophytes usually have protective hairs, thick skins and reduced evaporation surfaces. It is the aim of experimental ecology to determine whether these and other features of plants are responses to the environment or whether they are hereditary features and thus not adaptations in the strictest sense—that is, not adaptively developed. Experimental autecology has not as yet solved all these problems but it has shown that plants differ widely in their responsiveness. Some, such as the plants upon pond margins, are very plastic, responding quickly and adaptively to the slightest environmental changes, while other plants, such as the pines and their allies, appear to be rigid and unchangeable, whatever the habitat.

Observational Autecology. Most plant structures that are obviously adapted do not appear to be particularly responsive to the environment, whatever may have been true in their past history. Among the more obvious adaptations in plants are the floral structures that are concerned with the transfer of pollen from one flower to another (pollination) either by wind or insects. To cite an extreme case, the flowers of orchids are wonderfully complex and obviously adapted to visitation by insects. Such visitations are of mutual advantage, since the insect secures food and the flower receives pollen brought by the insect from another flower. These complicated floral structures have not been modified very much by experiment. The plant world is literally full of structures that have not been explained experimentally. We have here the choice of believing that structures once plastic are now fixed, or that they have been fixed from the earliest beginning. Obviously such interrelations of structure and behavior with environment belong to ecology, but ecology can for the present at least merely observe and not explain.

Experimental Synecology or Experimental Vegetation. Perhaps the greatest field of activity in plant ecology at present is in the study of vegetation. The vegetation of the world is divided into communities of one sort or another and the attempt is made to analyze and classify them. These communities are regarded not as static, but as ever changing landscape features. These changes are carefully observed as far as possible, and related to their causes. The factors of the habitat are investigated with the use of instruments for the measurement of evaporation, soil moisture, temperature, light and soil acidity, and the results of these measurements are related, as far as possible, to changes in the habitat and plant community.

Observational Synecology. The greatest limiting factor in interpreting the field of synecology is the time element. While changes in plant landscape are rapid in the geologic sense, they are slow in terms of human life. One may be very sure that a rock

lichen community will gradually be replaced by communities of higher plants, but the accuracy of the experimental method can hardly be applied successfully to such a problem. However, by observing many rock habitats of different ages, one may conclude that there is on rocks a succession of plant communities. It has been generally believed, for example, that the first rock plants are xeric lichens, followed later by xeric mosses, ferns and seed plants. After a long time come shrubs and trees. But the story does not stop here, for the second generation of trees is likely to differ from the first. The first trees are xeric and sun-requiring, but in their shade there come trees that are shade tolerant and less xeric. Eventually there come the most mesic trees that the region and the climate can support. These trees may be so shade tolerant that the successive stages stop and the same tree species may continue generation after generation. Such a climax is called a climax forest. A succession of this sort from lichens to climax may take from 1,000 to 10,000 years or even more. Obviously the concept of such a plant succession can be arrived at mainly by deductions from many field observations.

A succession that is somewhat simpler to analyze is that which develops from ponds. Vegetation establishes itself much more quickly in ponds than on rocks and the succession is more rapid. One of the commonest features of ponds is the presence of zones or belts of vegetation that surround them. In the deeper water are submerged aquatics, while in the shallower water near the margin are aquatics with floating leaves. At the edge are bulrushes, reeds and cattails. Back of these are grasses and sedges and further back are shrubs and trees. It is the belief of most ecologists that the belts of vegetation represent a counterpart of the history of the pond. That is, where now are trees there once were shrubs, while back of these were respectively sedges and grasses, bulrushes, reeds, cattails and pond aquatics.

While pond successions are believed to develop faster than rock successions, there is a type of succession that goes still faster, namely, one of the exposed clay banks of a newly dug canal. Here the first plants are not lichens, but xeric herbs which quickly give way to mesic herbs, shrubs and trees. The first trees may be more or less xeric and sun requiring, but the next generation is likely to be made up of mesic shade tolerant trees. Here a human lifetime may be sufficient to see the full succession from bare earth to a mesic forest. While the final stage of a plant succession may be called a climax stage, it is not always a mesic forest. In drier climates it may be a xeric forest, or a xeric thicket, a prairie or a desert.

Paleoecology. The most recent development in plant ecology is paleoecology, or the ecology of the vegetation of the past. While this field is still in its infancy it is likely to throw a flood of light on successional ecology in the study of present day communities. Paleoecology involves both autecology and

synecology. For example, in autecology one may perhaps by a study of the structure of fossil leaves gather some conception of past climates and past habitats. Paleocology pretty conclusively demonstrates the climatic and soil conditions under which the coal forming plants (Carboniferous) carried on their life activities. The most perfect preservation of Glacial and Post-glacial plants is in swamps and bogs. It is therefore possible to find in bog and swamp sections the exact successions of vegetation from the earliest formation of the pond in which the bog developed. This serves as an important check on the deductive method of successional study noted above. The data here are essentially as exact as data determined by the experimental method. These studies of glacial and Post-glacial bogs and swamps are based partly on wood, leaves, and other such remains, but more recently such data have been supplemented by the study of pollen grains, which are perfectly preserved in great numbers in bog strata; by studying the vegetation of the different successive bog layers it is possible to determine all the habitat changes and also the climatic changes since glacial times. The pollen grains have a special importance here because they may have blown in from a distance, thus making possible the determination of vegetation not only of the bogs themselves, but also of the surrounding territory.

Applied Ecology. Another recent development in ecology has been the organization of the subject of the ecology of crop production or applied ecology. Here are included all ecological features involved in agriculture and horticulture, such as the influence of soil water, atmospheric water, temperature, soil acidity and soil alkalinity. So important is ecology in this field that one may almost say that plant agriculture is in large part the application of plant ecology to crop production.

H. C. C.

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ANIMAL ECOLOGY

Animal ecology cannot logically be set off from plant ecology or from ecology in general except that in animal ecology the emphasis is put upon the relation of animals to their complete effective environment. Whether the emphasis is upon plants or animals, before the environmental relations of either have been fully visualized, the relations of both must needs be considered, for plants are important elements in the environment of animals and animals are almost or quite equally important in the plant environment.

The environment of animals is divided into two parts, the biotic and the physical. The first is composed of the other living organisms within the environment, the latter of the non-living elements. The physical elements of an animal's environment are temperature; water in all its forms, i.e., as solid ice or

snow, as liquid and as gas in humidity; air, including winds; chemicals, whether dissolved in water or mixed in air or composing soils and including quantities present as well as qualities; light, both intensity and quality of visible sunlight and the associated invisible infra-red and ultra-violet radiations; substratum, which includes the solid earth, whether soil or rock, and the bottoms or sides of bodies of water; pressure, including osmotic pressures, the reduced pressures of high altitudes and the greatly increased pressures of ocean depths. These could easily be further subdivided.

Of the biotic factors, there are other living organisms including parasites, whether Bacteria, Protozoa or larger organisms; for the parasite, the host organism, is of major environmental importance. Further there are food organisms whether plant or animal, alive or dead; protective organisms such as shade trees on land, or coral banks in the warm oceans; and finally there are the secretions and excretions of living organisms and the products of decomposition of dead animals and plants. Grouped together in various proportions and combinations these make up the effective environments of animals.

The distribution of animals depends fundamentally on whether the combination of all of these factors in a given habitat can be tolerated sufficiently to allow the animal to continue to live. This is the law of toleration. Stated generally it holds that animals cannot permanently succeed in regions where any one factor lies below the minimum limits of toleration for that species throughout the different stages of the life history, nor where the total combination of all factors cannot be tolerated.

Animals differ from plants most markedly in their inability to carry on photosynthesis and in their general motility. If conditions in a region approach the limits of toleration for a given animal, it readily undertakes a migration which may be limited to a few inches or may extend over hundreds of miles. Under similar conditions a rooted plant can only alter its growth form and if this is not sufficient to meet the environmental conditions, it dies on the spot. Species of animals may not occupy all habitats which they can tolerate because (a) they have not been in existence long enough to have migrated to the habitat; (b) because the habitat has evolved too recently for migration to have taken place; (c) because the species lacks vigor and is barely holding its own or is retreating to narrower and more favorable habitats; (d) because barriers of climate or physiographic features such as mountains or seas or deserts, or living enemies stand between its present location and the suitable but unoccupied environment; or (e) because suitable niches in the environment are already so fully occupied that the absent species cannot gain a foothold even if introduced.

There are three methods of approach to the study of the ecology of animals: one may determine the relations of an individual animal or of the species to its environment; or, since animals are always found

living in more or less loosely knit communities, these may be taken as the unit of study, in which case one must consider both the interrelations within the community and the environmental relations of the community as a whole. In the end, if a complete view of the many and complex relations between an animal and its complete environment are to be seen, the same ground will of necessity be covered regardless of the point of initial attack; for knowledge of the ecology of an individual is incomplete without knowing its position as a member of its species, its position in a community, and the relation of its species and its community to the other elements of its environment. Similarly, knowledge of the community relations must include information concerning the ecological relations of constituent species and individuals as well as of the community as a whole.

Study of ecological relations of individuals or of species is usually called "autecology" and the study of communities of organisms becomes "synecology."

Animal autecology is closely related to general physiology. Much of its content can be defined as being concerned with the general physiology of organisms in relation to their environment. Early workers in this general field were called students of natural history and were much concerned with the relations of one species of animals with other animals and plants. Later, as ecology first tended to become more exact, such work was neglected because of difficulties of exact description and of experimentation, and work in autecology of animals was focussed upon the relations of animals to the elements of their physical environments, as shown either by their behavior or by their physiological toleration of environmental complexes. Still more recently, as the importance of population numbers has been realized, there is a tendency to undertake the analysis of the interrelations between close animal groupings of the same or different species in what may be called studies in mass physiology. These studies in animal aggregations properly serve as a connecting link between the consideration of the environmental relations of individuals and of more complex communities.

The distinctive contribution to date made by ecology has been the establishment of the fact that all animals are of necessity members of more or less loosely knit communities, frequently geographic in extent which can be considered as complex units on their own account. These units are roughly comparable to that of a human village in which many individuals and families live. The exact formation of such a human community is constantly shifting; individuals, whole families and even groups of families come and go and yet the community may retain a distinct individuality even for generations. Just as the human relations within a village or other human community, of such communities with each other, and with the world in general constitutes the field of human sociology, so such studies of animal and plant life in nature are being recognized as aspects of bio-sociology, or if the emphasis is upon the animal community, as syn-

ecology, which is roughly equivalent to general animal sociology. Human sociology is thus seen to be but a specialized part of the whole field of synecology.

In human communities the ultimate unit is the individual, but individuals frequently are combined into small groups such as families or clubs which are themselves units of a higher order within the larger unit of the general community. So too with other animals, the larger communities may include, temporary, more or less unorganized aggregations of animals or closely organized colonies of definitely social animals, as of ants or bees or flocks of birds, herds of deer or schools of fish. The other relations of these more or less organized groups as well as the interactions between members of the same colony or aggregation are obviously an integral part of the content of animal ecology.

Just as human communities undergo development and evolution so do communities of other animals. The evolution of such animal communities forms one aspect of ecological succession which is similar in many ways to the succession of plant communities. Both start with the invasion of pioneer forms into a raw environment, and as the environment changes, due to physiographic forces, as in stream erosion, or to a combination of physical and biotic forces as in the formation of sand dunes, or to biotic forces as in protozoan infusions, the community passes through a number of more or less temporary evolutionary stages until finally a fairly permanent climax stage is reached which is immune to changes produced by itself and remains over extended periods, subject to climatic control, the influence of man and insect pests partially excepted. In many cases the animal communities are coextensive with the more obvious plant communities; in other cases they are not.

The value of an animal community is based upon a community of interest and the extent of a given animal community will depend upon whether general or specific interests are concerned. Thus we may have communities of the arctic tundra which circle the northern world or within the tundra we may recognize micro-communities no larger than a silver dollar. The exact classification of these communities is a matter which is under active discussion at the present time. The larger ones are generally called "formations" and are geographic in extent, while the smallest are frequently called "assemblies;" if primarily organized by habitat relationships they are called "associations" while if the organization is more definitely based on interrelations between the animals themselves, they are often termed "biocoenoses"; but large or small, closely or loosely knit, they may correctly be distinguished as communities.

In human communities we know that some of the forces binding the constituent individuals or subsidiary groups together are the necessity of receiving food supply, shelter from the elements and protection from other animals, including men, the necessity of mating and rearing of children; in general such communities are largely integrated by a drive for security.

In communities of which man is only an incidental part, many similar drives are operating to give the community definite structure. The exact nature of the integration of such communities is still a matter for research but we readily recognize organization about food requirements which we may call food chains and which may be illustrated simply by considering the food requirements of the black bass.

In the food of this fish are to be found fishes of different species at different ages of the individual, representing all the important orders of fishes, insects in considerable numbers and of great variety, fresh-water crayfishes, shrimps and a multitude of other small crustaceans. Looking at the food of the animals that form the food of these we find that the black bass at only the second step in its food chain is related to every class of animals, to many plants and to the decaying organic matter of its watery environment, and to the banks and bottom which contain it. Thus in considering the food chain relationship alone, we find that an animal community shows a closely knit web-of-life. Not only are there food chains but food pyramids as well, in which multitudes of relatively small "key-industry" animals live upon plants or their products and in turn are fed upon by fewer but more powerful individuals which reach their peak in the active predatory fishes of the seas or the carnivorous mammals of the land and birds of the air. These in turn are preyed upon, as is their food, by myriads of parasitic organisms, frequently microscopic in size as individuals, but important enough in mass to hold massive mammals in check.

Habitat relations, the struggle for an appropriate niche in which to live, is another integrating factor in the animal community as is also the finding of mates and the rearing of young. In many ways animals cooperate with each other unconsciously in the control of their habitat; this cooperation includes the elimination of toxic materials, the consumption of harmful plants, even such minute ones as yeasts and bacteria, and the aëration of the soil or mixing humus with it. In many cases animals can be shown to have important or predominant influence in determining the type of vegetation that can grow in a given region. In even more cases on land the plants determine their animal associates; thus trees meet the full impact of the physical environment and so modify its effects that associated plants or animals can tolerate the conditions which forests help to create; yet the growth of the trees themselves may depend on the absence or scarcity of rabbits or of insects as much as upon the presence of the proper soil and climate.

The study of structural or physiological adaptations is a part of animal ecology, as is also a study of life histories, but the subject matter is much broader than indicated by these elements of natural history. Its full consideration includes such topics as cooperation, population density and the resulting Darwinian principle of the survival of the fittest, migration and other aspects of geographical distribution, physiological adjustments of the individual animals to other animals,

to plants and to the inorganic environment, including their elimination if conditions arise which cannot be tolerated. It includes much of the matter dealt with in geological succession of life and is concerned with the conditions under which animals develop as much as with those in which they pass adult life. Much of the content of animal behavior and of the economic relations of animals to man both from an agricultural and from a medical point of view is inherently a part of ecology.

W. C. A.

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ECONOMIC BIOLOGY, the utilization of biological knowledge in solving the multifold problems involved in improving man's adjustments with other living beings, with the animal world on the one hand and with the plant world on the other. The consideration of the former is Economic Zoology, and of the latter, Economic Botany, although many interrelations between these two branches of science are inseparably intertwined.

Economic Zoology. In a narrow sense, economic zoology refers to the destructive work of insects, for example, and also to their beneficial relations to the crops which man seeks to harvest; but in its broader application it compasses practically the whole range of animal life. Man, as he succumbs to the diseases due to parasitic animals, is properly a phase of economic zoology.

Producing food, such as milk, butter, cheese, and the flesh of animals, constitutes a major industry in our civilization. The wool of the sheep and the hides of our domestic animals supply us with clothes and shoes, and we are almost as dependent upon these animals as were the ancient cave dwellers two hundred thousand years ago. In the United States more than 100,000 men annually gain a livelihood in the fisheries industry. A world view of economic fisheries is not available, but it doubtless affords a livelihood to more than one million human beings, as well as bringing to the inland dweller the food products of the sea. Although scientists have devoted a great deal of study to the biological factors governing the successful growth of fishes, we are to-day only at the beginning of an intelligent understanding of the conditions which control their life. Pollution of streams, microscopic life, and temperature are important regulating factors. While a great deal is known about the hatching and care of the young fish, we have yet to learn what proportion of them mature, what are the factors in migration, and the causes of some of their diseases.

Every book on economic zoology gives a large place to the life of insects. One of the important reasons why this has become necessary is that insects eat the food which plants have made and which man needs. Insects produce vast numbers of eggs, in a relatively short time. One of the common cabbage aphids

(*Aphis brassicae*) has been observed to produce 30 generations in a year. Had all of the possible individuals lived, there would have been some 564 quadrillion cabbage aphids, weighing about 824 million tons.

One of the early pests introduced into America was the Hessian fly, which was brought over in the straw used to bed the horses of the Hessian soldiers in the Revolutionary War. The litter from the stables was thrown ashore in New Jersey, and from that region the fly spread to all sections of the country. This single immigrant insect destroys as much wheat each year as would have paid the entire expense of the Revolutionary War.

More than one-half of the insects that cause incalculable losses of fruits and vegetables came from foreign countries. They may be said to have migrated to the land of plenty, for in their native homes either the amount of food was limited by the growing of small crops or their natural enemies were so numerous that they were themselves destroyed before they could do any marked damage.

The benefits that come from the life of insects are almost as conspicuous as their destructive features. Honey is an important food and the part which insects play in cross-fertilization of plants is very great. The conspicuous factors of animal economic life should not completely overshadow the life of the microscopic forms which have built up the great chalk cliffs, the coral reefs, and practically the entire soil of such an island as Bermuda. The lowly earthworm has been recognized for 100 years as one of the main tillers of soil.

Early man sought various forms of ornamentation, from necklaces to shields, and the use of the animals which served these purposes has been retained to the present day, as pearls for jewelry, mother-of-pearl for buttons, both taken from the clam and oyster. The red dye, carmine, is obtained from cochineal insects and shellac from the lac insect.

Mosquitoes prevented the French from completing the Panama Canal, and to-day life in the tropics demands a thorough understanding of animals in their relation to disease. In addition to making use of scientific knowledge to control forms of animal life that are injurious to man, economic zoology provides effective means for the improvement of those which are serviceable to man, as, for example, the establishment of the principles of selective breeding for livestock.

The wide range of Economic Zoology, then, compasses the whole of animal life and enters into many phases of our modern civilization. W. M. S.

Economic Botany. This deals primarily with the discovery of valuable plants, the investigation of their uses, their introduction into cultivation, their improvement by breeding, and their protection against diseases and enemies. Only the briefest outline of the uses of plants and a few examples can be given here.

The most important use of plants is and always has been as food. All organic food of animals, including man, is derived directly or indirectly from

plants and it is now known that the vitamins are also of vegetable origin. Several thousand kinds of plants are eaten by man, but the most important food plants, upon which the agriculture and horticulture of the world are based, are relatively few in number. Chief among these are the plants which produce starch or sugar in large quantity and palatable form and which are easily grown and harvested. The more important of these in temperate zones are wheat, corn, oats, rye, barley, potato, and sugar beet; in tropical climates rice, millet, sorghum, cassava, date, yam, banana, sago, and sugar cane. Among vegetables the various kinds of pulse (beans, lentils, peas), mustards (cabbage, turnip, cauliflower), onions (leek, garlic), and gourds (pumpkin, squash, cucumber, melon) are widely grown. Numerous plants are used solely for flavor, as vanilla, ginger and pepper. Non-alcoholic beverages are provided principally by coffee, tea, cacao (chocolate) and Paraguay tea; alcoholic by grape, rye, barley, agave and various palms. Tobacco, opium, poppy, coca and betel are the chief narcotics. Plants furnish a large proportion of our medicines; among the most valuable are cinchona (quinine), strychnos (strychnine), foxglove (digitalis), and opium-poppy (morphine). The microscopic yeast plant is indispensable in baking, brewing, and wine-making. Bacteria are used in many fermentation processes, such as cheese-making, and are highly valuable in the fixation of atmospheric nitrogen. The chief construction material of the world is wood. The chief fuel is also wood, while peat and coal are the carbonized remains of plants of past ages. Cotton, flax (linen), hemp, jute and sisal furnish valuable fibers and the mulberry, as food for the silkworm, also contributes largely to the textile industry. Hundreds of plants, including our house-plants, garden flowers and shrubs, and shade trees, are grown for their aesthetic value.

A host of industrial processes depend on plants or their products for raw materials. Wood or the woody parts of herbaceous plants are used for paper and artificial silk, and by distillation yield many valuable chemicals. Artificial gas and a long series of dyestuffs and other by-products are obtained by the distillation of coal. The softer parts of plants, composed largely of cellulose, provide insulating material and by chemical treatment yield numerous commodities, such as explosives and cellophane. Compounds of tannic acid, used in the leather industry, are furnished by many plants, especially oak, hemlock, and quebracho. Gums, resins, rubbers, and related substances are secreted by numerous plants and include such important articles of commerce as turpentine, rubber, gutta percha, balata, camphor, chicle (chewing gum), and lacquers. Volatile oils are used in medicine, in perfumery, as flavors and in various other ways. Fixed oils have a great commercial importance and are used in paints, soap-making and many other industrial processes, as well as in food. Among the most important oil-producing plants are flax (linseed), cotton, olive, tung, oil-palm, coconut, peanut, corn and castor bean.

Besides the vast array of useful plants, economic botany considers also those which are injurious to man, to domestic animals and to crop plants, ornamental plants and timber-trees, as weeds, poisonous plants and parasitic plants, causing disease.

H. A. G.

ECONOMIC GEOGRAPHY, the study of the relationships existing between man and the earth in the production and distribution of wealth, or in other words, the study of the relationships with the physical environment set up by man in his economic activities. The earlier economic geographers centered their study upon the influences of environment upon man, but in the more modern approach to the subject, it is recognized that man also influences and modifies his environment and may even control it, and the major emphasis is now placed upon the mutual interrelationships that exist between the two.

Economic geography draws material from two widely separated fields of knowledge. From **ECONOMICS**, it draws an understanding of economic principles and of economic enterprises; from **PHYSIOGRAPHY**, Climatology and soil science, it draws an understanding of the principal factors of the environment. The primary and distinctive contribution of economic geography is the synthesis of these two fields and the interpretation of their relationships.

Economic geography is an important division of the field of human geography coordinate with political, historical and social geography. It is itself usually subdivided into agricultural geography, industrial geography and commercial geography. Agricultural geography is concerned with the areal distribution of the production of the plants and domesticated animals utilized by man for food, shelter and raw materials for manufacture and with the relation of that distribution and of the methods of production to the environmental factors, especially relief, climate and soil. It also explains the influences of plant and animal life upon man's economic activities and upon the concentration of population and describes the accomplishments of man in altering his environment to promote agriculture through **IRRIGATION**, drainage and other processes of reclamation and land improvement. Fisheries as a source of food are commonly included in agricultural geography though they might well form a separate subdivision of economic geography in any systematic classification of the field.

Industrial geography is concerned with the manufacturing industries and with their location in relation to sources of power and raw materials, supplies of labor, consuming markets and transportation facilities. It includes also the study of the effects of manufacturing industries upon the concentration of population and the growth of cities and upon the strength of nations.

The term commercial geography is sometimes used rather loosely as synonymous with economic geography. More exactly, it is only one of the subdivisions of economic geography and is concerned with the environmental conditions leading to commerce be-

tween countries or regions, with the movements of commodities from the point of production to the point of consumption, with transportation routes and methods, with ports and harbors and trade centers and with their environmental background.

Economic geography is one of the more recently developed divisions of geography. The pioneer work in the field in English, Prof. George G. Chisholm's *Handbook of Commercial Geography*, published in London, did not appear until 1889. In its newer editions, it is still a standard text. Economic geography has been included in the courses of study of the universities and colleges of the United States for little more than 25 years and the first American university chair of economic geography was established just after the close of the World War. On the continent of Europe on the other hand, and in Germany especially, economic geography has long been a field of recognized academic importance and of practical application in business. The economic geographer contributed materially to the phenomenal expansion of Germany's foreign trade during the period between the formation of the empire and the outbreak of the World War. Included in the directing personnel of the large exporting enterprises was one member whose function it was to supply information on the environment, customs, industries, products and stage of development of foreign countries and on any other geographic topics that might have a bearing upon the promotion of German trade.

The belated recognition of the field of economic geography in the United States and the increasing emphasis that is now being placed upon it in education and business are responses to the fundamental economic transition through which the country is passing. As long as resources were abundant and seemingly unlimited, they were used wastefully and haphazardly, and little attention was given to their study. The settlement of land and the exploitation of forests and minerals and streams proceeded along individual lines and the occasional failures due to ignorance, however disastrous they might be, were lost sight of in the general success. A country so vast and so rich was largely self-sufficient and its people had little interest in other lands. As the resources have been depleted and the population has increased, there has been a growing recognition of the importance of utilizing the environment more carefully and more intelligently. Only the more difficult lands, those that are too wet or too dry, too hot or too cold or too distant, remain unoccupied and their successful settlement is possible only through the study and understanding of the environment. The interests of the country have expanded beyond the national boundaries and raw materials and food and markets are being sought in all parts of the world. The character of the foreign trade of the United States is undergoing a significant change. Manufactured goods are displacing food and raw materials in exports and the principal imports are no longer manufactures but crude rubber, raw silk, sugar and coffee.

The supply of capital is exceeding the opportunities within the country and the surplus is seeking investment in plantations and mines and factories in foreign lands. The field of economic geography with its analysis of environmental conditions and of the background of industry and of trade provides the knowledge that is required by the manufacturer in search of raw materials, the trader in search of markets, and the capitalist in search of fields for investment.

J. E. O.

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ECONOMIC GOODS. Goods are things which directly or indirectly satisfy human wants. Goods have utility. If the supply of a good is greater than necessary to satisfy everyone's desire for it, it is a free good; if there is not enough to go around freely, it is an economic good. An economic good, in the language of economics, is "scarce," although it may be relatively abundant. Economics deals only with scarce goods, which should be utilized to satisfy the more important wants. Our aggregate of material economic goods constitutes our total material wealth. Economic goods, with relation to the ultimate consumer, are either direct, or indirect. Direct goods are consumers' goods. A large amount of wealth, however, consists of indirect goods used in production—land, raw materials, stocks in trade and all sorts of capital instruments—and not available for consumers' use.

Not all economic utilities are derived from material goods. Many come from direct services performed by one person for another. These services are goods, though immaterial, else they would not command a price. They are immaterial economic goods. Their utility is not embodied in a material thing. Obviously they are not part of material wealth, although they are an important part of the stream of economic utilities. Such service utilities, derived from persons rather than things, constitute a part of income, and like material goods, can be evaluated in terms of price. The formal definition of an economic good as something commanding a price designedly ignores moral values or preferences.

A. B. W.

ECONOMIC INTERPRETATION OF HISTORY stresses economic influences as the predominant factors determining social activities. Proponents of economic determinism admit that other factors such as political, ethical or religious forces affect human activities and the development of social institutions, but they contend that these other factors play only minor rôles and are themselves the product of, and in large measure controlled by, the dominating economic forces. Economic determinism minimizes the rôle of great men. The supermen of history have affected human activities greatly only when society has been ready for great changes by reason of underlying economic conditions.

Because KARL MARX is generally recognized as the formulator of the doctrine of economic determinism,

the economic interpretation of history has been viewed with suspicion in some quarters as representing a form of socialist propaganda. There is, however, no necessary relation between a belief in economic determinism and adherence to the dogmas of scientific or revolutionary Socialism, since the doctrine of the predominance of economic forces does not carry with it the implication that private capital ought to be appropriated by the state in the interest of social welfare.

The doctrine of economic determinism is based on the obvious fact that the chief concern of mankind is to get goods enough at least to maintain life, and if possible to live in comfort or in luxury. Wants having throughout history outrun the supply of goods, struggles for the available supply have followed struggles between nation and nation, class and class, individual and individual. International wars, revolutionary wars, rebellions, strikes, business competition, combinations in restraint of trade, election campaigns, all represent for the most part economic struggles. The influence of economic struggles permeates all social activities—legislation, preaching of the gospel, scientific research, afternoon teas. History is replete with examples of the influence of economic conditions upon political, intellectual and religious activities. The American Revolutionary War grew out of economic conflicts. The Constitution of the United States has been called with good reason an economic document. Members of the convention which drafted it derived economic advantages from the new system and the votes for and against ratification were determined primarily by economic considerations. The Civil War was the culmination of a struggle between two rival economic systems—slavery and free labor. Slavery grew in the South where it was profitable and declined in the North where it was not. Where it was profitable it was found by the preachers to be a divinely ordained institution; where it was not, it was found to be vile and reprehensible.

The doctrine of economic determinism has had distinct scientific value in bringing a recognition of the close relation between economic and other social activities. It has made history a more fascinating and fruitful study by substituting for the narrow concept of history as past politics, the broader concept of history as past social activities of diverse kinds, all influenced and in large measure unified and controlled by economic forces.

L. A. R.

BIBLIOGRAPHY.—E. R. A. Seligman, *The Economic Interpretation of History*; C. A. Beard, *An Interpretation of the Constitution of the United States*.

ECONOMIC LAW. A law, in the scientific sense, is simply a brief statement of the observed repetition of sequences and coexistences. A law states how things act, if they act repeatedly in the same way. A valid law, in the natural sciences, is a basis of prediction, since nature is conceived as a realm of uniformity and repetition. Whether economic life is sufficiently repetitive to be subsumed in scientific laws is doubtful. Economic processes, including the human element, are too complex and too changeable. If any

economic laws can be formulated, they are emphatically merely statements of general tendencies, which may or may not continue as time goes on, according to the course taken by social change in the future. The classical economists thought they had discovered fundamental economic tendencies or laws, valid for all times and places. Belief in the universality of economic laws, other than such a law as that of DIMINISHING RETURNS, or factoral proportion, which is really a physical law, or as that of supply and demand, so broad that it has no definite significance, is not now common among economists. A law or principle may be valid for one stage of economic life but untrue and worthless for another. The modern trend of economic thought views economic life not as a set of static, repetitive relations and equilibriums, but as a continuous change or evolution, a historical process. Such laws or principles as may be formulated, therefore, are to be accepted as applicable only to the time and phase of this evolution for which they are formulated and from which they are derived. The more ECONOMICS becomes the study of economic evolution, the less economists will consider immutable principles, or talk of "inescapable laws of economics." A. B. W.

ECONOMIC MAN, an abstraction found more frequently in writings about economics than in economics itself. DAVID RICARDO, having made a fortune on the London stock market, where if anywhere the economic man should be looked for in actual flesh, held that economic relations can be adequately analyzed, so far as principles are concerned, by ignoring all motives save desire for wealth and aversion to sacrifice. This was equivalent to positing an economic man, an individual motivated almost entirely by self-interest, and indeed by a self-interest of a narrow and material character. The economic man can best be defined in terms of the economic principle, i.e., all men, in their economic activities, seek as much income for as little effort or sacrifice as possible. The economic man is a man whose behavior conforms to this principle. It was generally assumed also that the economic man knows his own interests (enlightened self-interest) and that he has perfect freedom to pursue them so long as he does not interfere with a like freedom in others (free competition). Both the economic principle and the economic man were derivatives from the hedonistic psychology of the Bentham school, which deeply influenced the English economists from Ricardo to the early writings of JOHN STUART MILL. The economic man was introduced to simplify the human element in economics sufficiently to permit rigid logical deduction of the laws and principles which, it was thought, must be true of the normal and ideal state in which every man is free to seek his own interests intelligently and does so. The system of political economy which resulted from such simplification and abstraction could not truly reflect the concrete facts of the changing institutional life of an actual economic society. A. B. W.

ECONOMICS, the name given to a general field of knowledge primarily concerned with social or-

ganization for the production and distribution of WEALTH. The term is roughly synonymous with the older designation of political economy, though with time the term economics has tended to release itself from the connotation of establishing rules of public policy which attached itself to the earlier term. Brief definitions of economics are numerous and unsatisfactory, and one may perhaps approach the meaning of the term rather from the angle of the range of studies which are included under it. In its character of a social science the subject-matter to which economists apply themselves and the methods of analysis which they utilize are the best guides to an understanding of the nature of economics as a scientific discipline.

It may be said that the pursuit of wealth is a perennial and necessary aspect of human life and activity. In the simplest sense there is a compulsion dictated by the biologically necessary adjuncts of human survival. Beyond such necessities the efforts of mankind are dictated by an expanding range of desires which are, in any given time and place, those for conventionally necessary or desirable modes of consumption and for desirable forms of activity. In a very fundamental sense what men do, what their desires are, what their activities are, reflect a certain psychological motivation which arises out of the manner of creatures which they are. It is of the essential nature of man to organize in social communities and to prescribe common rules which limit and define the activities of individuals. In whatever state of civilization they may be, men are bound to create forms of organized provision for their essential needs of food, shelter and clothing, and for whatever further desires their knowledge and resources permit to be satisfied.

The knowledge necessary for providing the goods and services needed or desired is, on the one hand, of a technological sort. The degree of man's ability to satisfy his wants is limited by his ability to fathom and harness the forces of nature, and the cumulative accretion of such knowledge passed on from one generation to another provides the necessary basis for our modern abundance of material wealth. On the other hand, however, with such accumulation of knowledge, there goes, pace by pace, a general change in social structure, in the relations of man to man, of class to class, and of the individual to the community.

In this large social process the term economic is applied to those aspects of social organization and activity most directly related to the creation and distribution of wealth. Since in our present society such activity takes the proximate form of pursuit of a MONEY income, economics is sometimes defined as the science of such of man's activities as are measurable in terms of money, or, alternately, the study of phenomena from the standpoint of price. While it is true that money enters into most economic transactions, it is equally true that such transactions are delimited by a complex of social institutions such as laws of property. In consequence economic studies may be re-

garded as being equally concerned with the nature of economic institutions, and with the operation of the forces, measurable in money, which operate in our given set of institutions.

It will be evident that in reducing so extensive and complex a subject-matter to the status of an orderly body of knowledge, recourse must naturally be had to specialized research and to a variety of methods of analysis. In the field of research there have been developed a great variety of special monographic studies in such fields as corporation finance, money and banking, labor organization and employment relations, transportation, public utilities, business organization and so on. Such material, periodically brought up-to-date and summarized in more general treatises, furnishes what may be called the descriptive content of economics.

Historically, however, the scientific aim of economics has gone far beyond the mere accumulation of descriptive data. It has been felt desirable, or necessary, to subject the processes of economic activity to such scrutiny as would lead to valid general statements concerning the nature and effect of the forces at work. This may be illustrated by saying that economists are interested not merely in the existence of corporations, nor in an accurate description of their form, but in the reasons for the growing dominance of the corporate form of organization and in the social consequences. Likewise, they seek not merely data about *WAGES* or *PROFITS*, but a capacity to explain their amounts, absolutely and relatively. They do not merely observe the cyclical fluctuations of business, but seek to explain them.

In a very fundamental sense, then, the preoccupation of economists is with explanations, with relations of cause and effect, and their efforts in this direction have been generally regarded as constituting their uniquely scientific activities. The results, such as they are, are imbedded in a special economic literature known as economic theory. Such generalized explanation of economic phenomena is not, obviously, the direct result of observation or collation of data. It cannot proceed without intimate knowledge of facts, but it is in its essential character the outcome of a process of thought. In attempting to understand the character of economics it is therefore quite as important to know the manner of thought which economists bring to their data as it is to know the range of data upon which they exercise their analytical talents.

One of the most commonly used methods of economic analysis is that of deductive reasoning. The use of this method requires the assuming of a fixed state of economic organization and the existence of certain uniform motives. The essential idea of economy is that of organization for the purpose of reaching a given result with a minimum means. The essential postulate of economic reasoning is the general pursuit of personal advantage. Thus in the analysis of wages it is assumed that workers are seeking a maximum remuneration; in the analysis of business enterprise

it is assumed that business men are seeking to reduce their costs to a minimum. By assuming the operation of self-interested motives operating in competitive markets, it is possible to construct a general integrated theory of the reasons for the relative prices of commodities, the rates of remuneration of productively employed persons, the uses of land, the forms of business organization, the location of industries and so on.

The difficulty with such theory is that the explanations are only applicable to the actual world in so far as the assumed conditions are true. Thus if men act ignorantly or perversely or philanthropically, or if markets are controlled or monopolized, the theoretical results obtained are made inaccurate or untrue. It was once generally believed that a relatively accurate science of economic life could be constructed by such a process of deductive reasoning. The present tendency is to regard this method more modestly as a necessary instrument for analyzing certain economic situations. Thus, one may deduce some of the effects of raising a tariff, or of passing a farm relief bill, or of a diminution of the world's gold supply, or of a technical improvement in industry. In a more general way, one may gain thus an insight into the whole complex of economic processes which he could attain in no other way. Fundamentally what this method permits is, upon a basis of observation of the forces at work, a statement of the nature of the effects which they will produce.

Another important method of economic analysis is the statistical, or quantitative. In its simplest use, it is merely a convenient way of numerical summarization. It may also be used as a complementary instrument wherewith to check the results of economic reasoning, as for example the relation between the volume of money and the general level of prices. It introduces, however, the possibility of arriving at new relations of cause and effect by the correlation of time series. Such series, as for example, those used in the analysis of *BUSINESS CYCLES*, such as price series, interest and wage rates, profits, volume of physical production and the like, in themselves indicate no causal factors, but charted against one another may, when interpreted with judgment, permit sequences to be translated into tentative statements of cause and effect. Or, if no such translation is attempted, the sequences themselves, if recurrent, may represent a substantive addition to our scientific knowledge of economic processes.

A further method of economic analysis is what is frequently called the genetic method. By this is meant the explanation of given phenomena or situations by tracing through time the accumulation of causes which have given rise to them. The method does not lend itself to accurate statements, since the process of cumulative causation leading, say, to the price of sugar in New York on January 1, 1931, would have consisted of infinite ramifications in past time. For such problems, the methods of description, deduction and statistics seem more generally appropriate. On the other hand, the genetic approach em-

phasizes the evolutionary change in economic institutions, and underlines the fact that the proximate explanations of economic situations are relative to a given set of institutions which are subject to change. This approach emphasizes the degree to which the activities usually called economic are but aspects of the total behavior of mankind. Thus, social behavior may be classified as economic, political, legal, ethical and so on. But obviously the laws passed, the decisions rendered, or the moral ideas entertained are of importance in defining the limits within which economic transactions occur. Plainly no account of the operation of economic forces could be exactly the same for Soviet Russia and the United States.

The foregoing remarks have a bearing upon the nature of economic laws. They have no such permanent character, as, for example, the law of gravitation. They are strictly relative to time and circumstance, and are only such generalizations as can be made about uniformities of human behavior, which derive from certain generally operative motives, acting in conjunction with the resources of nature's provision, a given state of knowledge of the industrial arts, and a given system of human institutions. Moreover, they in no sense prescribe the right or proper rules of economic conduct, nor dictate the forms of economic organization most conducive to human welfare.

To this point economics has been treated as a science concerned with the explanation of certain types of behavior primarily related to the creation and acquisition of wealth. If it were no more than this, its interest would be purely intellectual and academic. Actually, however, most economic studies have some more practical aim. The complexity of our modern society has created a variety of problems which have progressively to be solved. Thus, for example, there is general concern over banking systems (*see* BANKS AND BANKING), the control of transportation systems, the unequal distribution of wealth, the periodical appearance of trade depressions with consequent loss of livelihood to workers and the like. To effect any solution of such problems requires knowledge obtained by investigation and analysis. It is one of the primary functions of economists to have such knowledge, and to perfect the instruments of analysis whereby the probable effects of certain lines of action may be at least dimly foreseen. The uses to which their knowledge may be put is legion, in forecasting certain effects of a rise in the discount rate, or certain adjustments which would follow the setting up of UNEMPLOYMENT INSURANCE, or the immediate and more distant effects of a plan of FARM RELIEF, or the diverse effects of new forms of TAXATION. More generally, they may also supply the knowledge for some comparison of the effects of innovations in our institutional structure, such as NATIONALIZATION of industries or the abolition of inheritance.

There is, in a certain sense, an art of economics, the art of perfecting the social arrangements through which the wants of individuals are satisfied and the

essential functions of economic society performed. Such social structures are not, however, created by economists. They grow, and in their growth reflect the human motives upon which their existence is conditioned. The economic organization of society further reflects both the expanding knowledge of natural forces on the one hand, and the countless frictions or conflicts of interest between individuals and groups on the other. The laws of social development, if they may be said to exist, are obscure. Nevertheless, since the direction of the development is fixed as the complex resultant of the play of human motives, there has developed a belief, or hope, that intelligence may be made to control the development in the interest of the well-being of the group, as contrasted with the attainment of the narrower ends of individuals or groups. While economists are not in a position to dictate, and are not competent to dictate, the ends which shall be pursued, it is to the science of economics that the community, or its leaders, must have recourse for specialized knowledge of the economic structure with the improvement of which they are perennially concerned. *See also* AGRICULTURAL ECONOMICS; AUSTRIAN SCHOOL; CLASSICAL SCHOOL OF ECONOMICS; INSTITUTIONAL ECONOMICS; MANCHESTER SCHOOL; PHYSIOCRATIC SCHOOL; PRIMITIVE ECONOMICS.

P. T. H.

ECONOMIZERS, special FEED-WATER HEATERS of the closed type, located in the flue between the BOILER and the chimney to utilize part of the waste heat of the chimney gases. Two types of economizers are in use, those having cast-iron tubes and those with steel tubes. Cast-iron-tube economizers may be used on boilers operating on low pressures, and were formerly used exclusively because of their corrosion-resisting qualities. High pressures necessitate the use of steel tubes, but these must be protected against corrosion internally and externally by corrosion-resisting coatings. Cast-iron coverings are sometimes used, and when these are in the form of thin, large-diameter rings, the economizer is of the extended-surface type.

ECONOMY. *See* CREDIT ECONOMY; MONEY ECONOMY; BARTER.

ECORSE, a suburban residential city in Wayne Co., Mich., situated on the Detroit River about 9 mi. southwest of the center of Detroit. It is served by the Michigan Central, the Lake Shore and Michigan Southern, and the Detroit, Toledo and Ironton railroads. Although predominantly a residential city for Detroit business men, Ecorse has important engineering works and salt factories. In 1929 the retail trade amounted approximately to \$2,110,000. Pop. 1920, 4,394; 1930, 12,716.

ECSTASY, the state of psychic exaltation through absorption in an intense emotional contemplation; the religious ecstasy of priest or disciple in devotion is typical. In ecstasy the subject is lost to the outer world and may assume a rigid position, and consciousness is narrowed to one objective in a passionate absorption. The word is more liberally used in connection with extreme states of emotion of a joyous tone.

ECTOPLASM, a name coined to explain the appearance of a vaporous frothy mass emerging from the mouth of a medium; the word suggests that it is living substance formed from the outside. The hypothesis is extravagant and would lead, as Richet maintains, to a **METAPSYCHICS**. He holds that living matter is produced by mediums as ectoplasm. There is no scientific basis for such a statement. It is further urged that such life-stuff is an early stage of the development of the arms and faces of the complete figures which appear in the medium's cabinet. The evidence is convincing that these **MATERIALIZATIONS** are fraudulently produced. The term shows to what extent believers in spirit phenomena will go, by dismissing uncritically the hypothesis of fraud.

Eva C. is the medium who first produced this phenomenon. It was imitated by other mediums, notably Katherine Golligher in Belfast, whose sponsor, an engineer named Crawford, maintained that these psychic structures actually grew out of the medium's body, supported a table, and were then reabsorbed by the medium. After Crawford's death an investigator who believed in the reality of ectoplasm detected fraud in this medium. The case of "Margery" in Boston aroused controversy; but the majority of the committee gave a verdict of fraudulent concealment of tissue on her person.

As all the physical phenomena of **SPIRITUALISM** have been proven fraudulent, ectoplasm may be added to the list as an amazing instance of the extravagant hypotheses resorted to in order to explain appearances for which intentional deception is the only alternative.

J. J.

ECTROPION AND ENTROPION. See **EYE**, **AFFECTIONS OF: Malformations.**

ECUADOR, a republic of South America, on the Pacific coast, extending from about 100 mi. north of the equator to about 400 mi. south of it, and bounded on the north by Colombia and on the south by Peru. The area is estimated at 118,627 sq. mi., but boundaries are in dispute and Ecuador's extreme claim is 275,000 sq. mi. Estimated pop. 1929, 2,533,000. **QUITO** is the capital and **GUAYAQUIL**, the chief seaport.

Surface Features. Ecuador has three longitudinal sections, the coastal zone; the inter-Andine region, including the mountain ranges with the plateau or valleys between; the trans-Andine, a part of the Amazon basin. Ecuador is the only country in South America favored on the Pacific with rivers navigable to any considerable extent, and the dense tropical vegetation of much of the coast is in striking contrast to the Peruvian deserts. The central mountainous region belongs to the great chain of the Andes. Extending from a rather confused mass near the boundary of Peru to another jumble of peaks at the Colombian border, a distance of 300 mi., are two parallel ranges from 20 to 30 mi. apart. The plateau region between is separated by two lower transverse ridges into three shallow basins or plains, those of Quito, Ambato and Cuenca. The first basin has an altitude of 9,500 ft., the second, 8,500 ft. and the third 7,800 ft. East

and west are the two rows of mountains in a remarkable symmetrical arrangement. Nowhere else in the world are there two such rows of giants or such a collection of snow-crowned volcanoes. Of the 22 great peaks, several are active volcanoes. The highest peak, **CHIMBORAZO**, is in the western range. The mountains slope down into the forests, which cover their lower eastern declivities, and the plain beyond. This inclines toward the region of the Amazon, with slight inundations well away from the mountains, but the nearer sections are broken by lateral spurs from the main chain, or by low isolated ranges separating the basins of the large Amazon affluents.

Climate. The climate of the several sections varies, chiefly on account of the altitude. The coastal region is warm with a mean temperature of 82.4° F., but with variation in humidity and rainfall. South of the equator the coast is arid with little rain, but farther north rain and luxuriant vegetation occur. Toward the mountains, the climate, though warmer, is agreeable in the dry season. In some sections there are two rainy and two dry seasons a year; in others it is likely to rain at any time. In Ecuador the dry season, though the cooler, is called *verano* or summer, while the warmer rainy months are called *invierno* or winter.

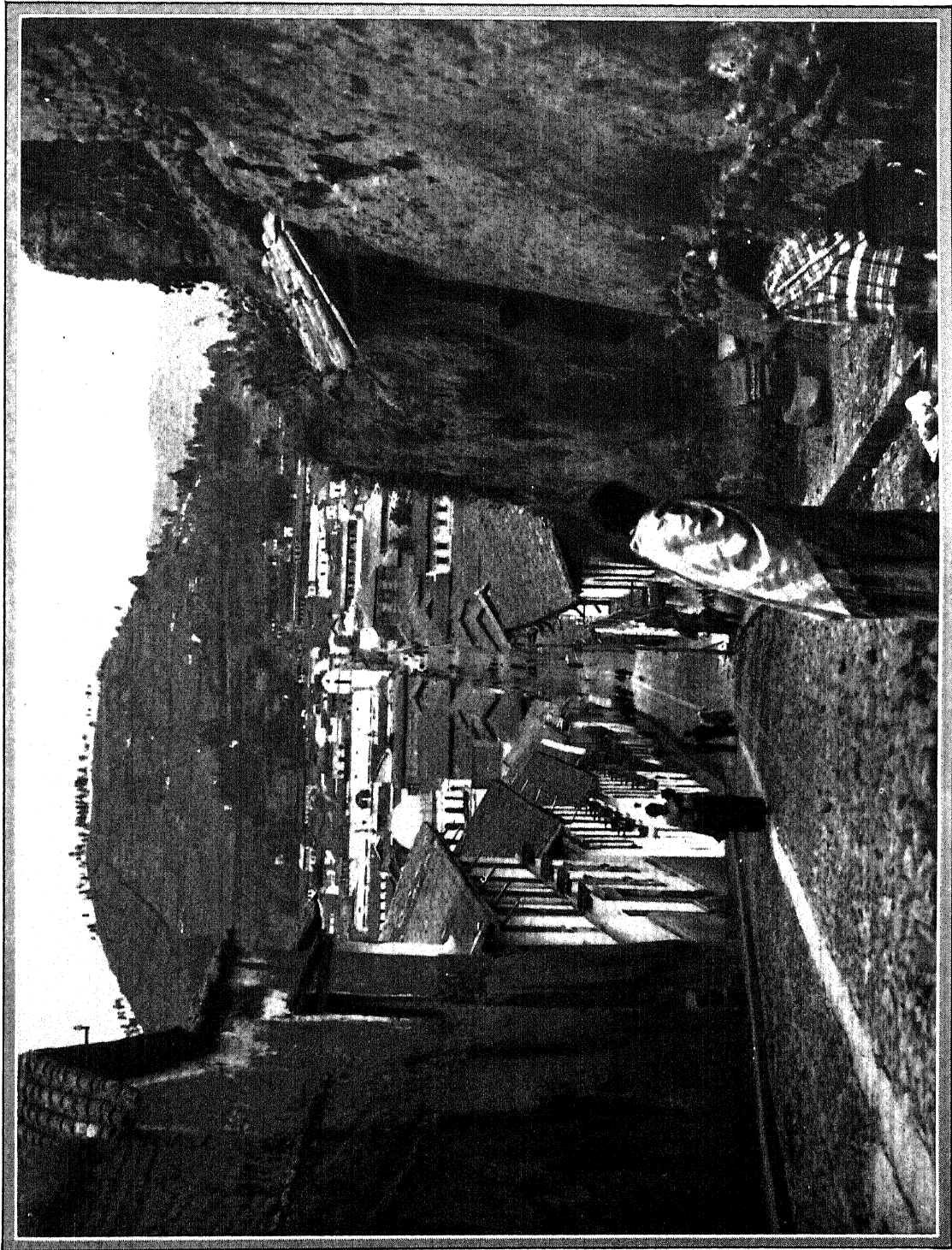
Forests. Among the five leading exports of the country three are derived from forest resources, tagua nuts, Panama hats and rubber. Moreover, a lumber industry centered about Guayaquil and Esmeraldas supplies products for domestic needs, although the paucity of transportation facilities blocks expansion. The palm fiber (*Carludovica palmata*), used in making Panama hats, hammocks and other articles, gives employment to many people.

Cacao. For a long time Ecuador dominated the world's output and market of cacao, contributing one-third of the total in 1900 but less than one-eighth in 1929. Although it led all other producing regions until a few years ago, expansion in Ecuador did not keep pace with world consumption and the production in other regions. The exports of cacao rose gradually from about 2,000,000 lbs. in 1850 to 41,000,000 in 1900; then they rose to 109,000,000 lbs. in 1916, the peak year of shipments. The *monilia* disease, which attacks the fruit, broke out in 1916 and caused great losses. The industry had not recovered from this setback when the "witches' broom" disease, which attacks the trees, broke out in 1922 and caused the abandonment of many plantations. Exports decreased to about 35,000,000 lbs. in 1928.

Mining. Ecuador is not an important producer of minerals. There is one gold mining region, Zaruma, that produces rather steadily about \$500,000 worth of gold yearly. Beds of low-grade coal have been found in several places, but the absence of suitable transportation has discouraged mining operations. Some interest in petroleum has developed in the oil fields of western Ecuador, but the output is not large.

Industry. The Pacific lowlands of Ecuador are considered the potentially richest region of tropical

ECUADOR



E. B. HOIT PHOTO, COURTESY R. I. NESMITH AND ASSOCIATES

A STREET IN QUITO, CAPITAL OF ECUADOR

The smooth stone path in the middle of the cobble street is for those who walk barefoot.

western South America. To Ecuador, they constitute practically the only source of revenue. Most of their wealth depends upon their almost ideal adaptability to the growth of cacao along the rivers flowing into the Guayas. In addition, the collection of tagua nuts, the manufacture of Panama hats, the commercial production of coffee and cotton and a small amount of grazing tend somewhat to round out the industries of the region.

Inhabitants. As in several other South American countries, a small, landed, white aristocracy owns most of the valuable land which is held in vast *haciendas*; this group composes less than one-twelfth of the entire population. The moneyed element has shown little interest in the country except to obtain profits with least effort. Voluntary expatriates are numerous. The lower strata of population embrace Indian, Negro and mestizo who labor on the cacao and coffee estates, weave Panama hats, gather tagua and rubber from the forest and in cases abstain almost completely from commercial intercourse. They have no inclination for work for more than the necessities of life, which for them are few.

HISTORY

The pilot Bartolomé Ruiz, the first European to visit the shores of Ecuador, reached the Esmeraldas in 1526; later in the year, with FRANCISCO PIZARRO and Diego de Almagro, he followed the coast as far southward as Atacames. In 1529 Pizarro was appointed captain-general, with rights of discovery and conquest, of New Castile, including Peru and Ecuador. He invaded the north of Peru, captured and executed the Inca monarch ATAHUALPA, who had reigned at Quito, and thus ended the Inca empire. The region of Ecuador was conquered by one of his captains, Sebastian Belalcázar, and the city of San Francisco de Quito was founded in Aug. 1534, on the site of the Indian town. Gonzalo Pizarro was appointed governor of Quito by his famous brother in 1540, and the region formed part of the viceroyalty of Peru. The *audiencia* of Quito was established in 1563; its president, nominally a judicial officer, came to exercise executive authority also.

In 1717 the administrative authority over the region was transferred to the new viceroyalty of Santa Fé de Bogotá; returned to Peru in 1722; placed again under Bogotá in 1739, where control remained until Ecuador became a republic. The revolution against Spanish rule began in Quito, Aug. 10, 1809, and attained final success on May 24, 1822, when the royalist forces were defeated at Pichincha. At the instance of SIMON BOLIVAR and Sucre, Ecuador, corresponding to the *presidencia* of Quito, was incorporated in the Colombian republic; but a separatist movement, headed by Gen. Juan José Flores, was successful, and on Sept. 22, 1830, the first constitution of Ecuador was promulgated. The Carchi River was named as the boundary between Ecuador and New Granada (see COLOMBIA) in 1832.

The first constitution, strongly conservative, made

Roman Catholicism the exclusive religion. Liberal opposition to the important privileges of the Church and to Flores's extensive powers gained strength; the principle of republican government was extended by the new constitution of 1835, and a Liberal, Vicente Rocafuerte, headed a reform administration from 1836-39. Flores was again President until Mar. 1845, when a revolution checked his dictatorial aspirations. There followed a tumultuous period marked by changing constitutions, war with New Granada, and war, over boundary issues, with Peru. Gabriel García Moreno dominated Ecuadorian politics from 1861-75, an era marked by great increase of clerical influence and religious fanaticism but also by material improvements. A period of civil turmoil, dissension between Clerical and Liberal factions, and uncertain finances followed. After a military victory over the Government troops, Gen. Eloy Alfaro, a Liberal, became "Supreme Chief of the Republic" in 1895, and undertook to free Ecuador from clericalism and institute social reforms. The notable constitution of 1906, Ecuador's 12th, expressed these aims. The Liberal Party, having become dominant, developed internal factions; in 1925 a Socialist Party came into existence. A military coup d'état in July 1925 ushered in the provisional Presidency of Dr. Isidro Ayora, who introduced important economic and fiscal reforms, and after a revision of the constitution in 1928 was elected constitutional President in the following year. In the face of increasing economic difficulties he resigned in Aug. 1931, and in October Neptali Bonifaz was elected President.

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ECZEMA, a term very loosely applied to almost any skin disorder. More strictly speaking, it refers to an inflammation of the skin, acute or chronic in nature, presenting eruptions varying in nature, which are either moist or dry. In the most acute forms there may be marked redness and blistering. In chronic varieties there may be only scaling and thickening of the skin. Itching is a troublesome symptom in all forms and scratching aggravates the condition.

Some authors include under eczema, skin inflammation caused by external irritants, such as chemicals. Others use the term only when the condition is due to internal causes. In some cases of eczema, foods or drugs taken internally may be causative factors (see ALLERGY). In infantile eczema, the rash sometimes appears after cow's milk has been substituted for human milk.

In the treatment of eczema an attempt should be made to find the cause and if possible remove it. Locally soothing lotions and ointments should first be applied to diminish the itching and supply protection. Irritants, particularly soap and water, should be eliminated from contact with the skin. The diet and mode of living must be fitted to individual requirements.

EDDA, the title of two collections of ICELANDIC LITERATURE, one in poetry, the other mainly in prose. The poetic Edda, including usually 32 mythological and heroic poems, of unknown date and authorship, was collected from oral tradition and committed to writing probably about the 13th century. An erroneous ascription to Saemund Sigfusson led to its being called Saemund's Edda. The prose Edda, the three oldest MSS. of which belong to the early part of the 14th century, was the work of Snorri Sturluson (1178-1241), and is divided into five sections: Preface, Delusion of Gylfi (*Gylfaginning*), Sayings of Bragi, Art of poetry (*Skaldskaparmal*), List of Metres (*Hattatal*). It was intended as a manual for the use of poets.

EDDINGTON, SIR ARTHUR STANLEY (1882-), English astronomer, was born at Kendall, Dec. 28, 1882. He was educated at Manchester and at Trinity College, Cambridge, became chief assistant at the Royal Observatory, Greenwich, in 1906, and in 1913 was appointed Plumian professor of astronomy at Cambridge. He is known principally for his work on the motions of the stars, for his early appreciation of the theory of relativity, and the part he played in having it universally accepted, and, later, for his pioneer researches on radiative equilibrium and the internal constitution of the stars. Among his publications may be mentioned *Stellar Movements and the Structure of the Universe*, 1914; *Space, Time, and Gravitation*, 1920; *Stars and Atoms*, 1927; *The Nature of the Physical World*, 1928; and *Science and the Unseen World*, 1929. He was knighted in 1929.

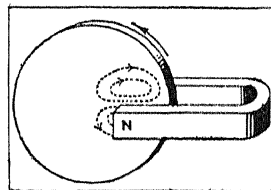
EDDY, MARY BAKER (1821-1910), founder of the Church of Christ Scientist, was born at Bow near Concord, N.H., on July 16, 1821, the sixth and youngest child of Mark and Abigail Baker, who belonged to a well-known New England family. In 1843, she married Maj. George Washington Glover, who died of yellow fever in Wilmington, Del., within a year. A posthumous son, named after the father, was born. Maintaining herself as a writer, speaker and teacher, the young widow revealed great ability. In 1853 she married Daniel S. Patterson, a dentist of Franklin, N.H., from whom, in 1873, she obtained a divorce. During the evening of Feb. 1, 1866, Mrs. Eddy, then living at Lynn, Mass., fell on the ice, was stunned and subsequently attended by a physician who found that she had suffered internal injuries of a serious character. Three days later, as she has written, she called for her Bible, read Matthew 9:2, a verse describing the miracle of a man sick of the palsy, and herself rose similarly from her bed. She dressed herself and soon was fully recovered from the injury. After this experience Mrs. Eddy devoted her career to developing and teaching the beliefs, outlined under the title **CHRISTIAN SCIENCE**. In 1877 she married Asa Gilbert Eddy, who was the first of her disciples publicly to practice spiritual healing. He died in 1882.

Like the Wesleys, Mrs. Eddy did not contemplate,

at the outset, a separate organization for her movement, which she held to be a contribution to existing churches. But in 1879 the First Church of Christ, Scientist, was organized at Boston, and Mrs. Eddy directed what became a world-wide community of believers. In establishing her faith, Mrs. Eddy was called upon several times to defend her teachings and her organization in the courts. Mrs. Eddy was a woman of compelling personality. She made her home at Chestnut Hill, in Newton, Mass., and died there on Dec. 3, 1910.

BIBLIOGRAPHY.—Sibyl Willbur, *The Life of Mary Baker Eddy*, 1923; Lyman P. Powell, *Mary Baker Eddy: A Life-Size Portrait*, 1930; Hugh Studdert-Kennedy, *Mrs. Eddy As I Knew Her*, 1931.

EDDY CURRENTS, electrical currents which are induced in a metal mass by a changing magnetic field and which flow in small closed paths. If a copper disc such as is in the figure be rotated between two arms of a horseshoe magnet an electromotive force will be induced in the disc (see **INDUCTION**). This electromotive force will set up local currents (as shown in the figure) which heat the disc and necessitate a greater expenditure of work for rotation. Eddy currents thus result in a definite



EDDY CURRENTS, SHOWN IN DOTTED LINES, INDUCED IN THE DISC WHEN IT ROTATES IN THE MAGNETIC FIELD

loss of energy and commercial apparatus must be specially designed to reduce the current flow. Metallic parts subjected to a varying magnetic field are built up of laminations set at right angles to the eddy current flow. These laminations interpose high resistance to the flow of current and thus reduce heating and improve efficiency.

EDELWEISS (*Leontopodium alpinum*), a white, woolly perennial herb of the composite family, native to the Alps of central Europe and more or less grown in rock gardens. It grows from 4 to 12 in. high from creeping rootstocks, with oblong entire leaves and small, closely clustered heads surrounded by a tuft of very woolly floral leaves. The plant, regarded as an emblem of purity, and locally often very rare, is eagerly sought by Alpine tourists.

EDEMA, the condition resulting when fluid passes from the blood vessels into the tissues more rapidly than it is absorbed or drained away, commonly called dropsy. As a result, the tissues become swollen, soggy with fluid, and inelastic. Depending upon circumstances, edema may be localized in any part of the body, or it may be general.

Some of the factors known to influence edema are the permeability of the **CAPILLARY** walls, the inefficiency of the kidney as a filter, the relation between pressure in the blood vessels and in the tissues, the saline composition of the blood, and the inefficiency of the lymphatic system for drainage. It is probable that the mechanism of water regulation is a complex

one depending upon the interaction of the above factors. The master regulator is apparently a nerve center in the hypothalamic region of the brain.

Swelling of the legs, especially of the ankles, is a leading symptom in disorders of the heart which are accompanied by decompensation of its action for the needs of the body. In disease of the kidney (*see* NEPHRITIS), edema develops first in the lax tissues about the eyes. Some believe that such edema is due to an ACIDOSIS, which is an abnormal accumulation of acid in the blood. Also, if certain toxic substances are present in the body, the altered permeability of vessel walls results in an edema. A local example of such a condition is the swelling which accompanies INFLAMMATION. Angioneurotic edema, which appears spontaneously in circumscribed regions, such as the face, backs of hands, legs, or throat, accompanied by gastro-intestinal attacks, is evidence of the influence of nervous regulation on edema. *See also* GASES AND ATMOSPHERES, INJURIOUS.

EDEN, in Biblical account, the paradise or garden in which man and woman were placed by God after the creation and before the fall of man. Students



THE EXPULSION FROM THE GARDEN OF EDEN

A medieval interpretation from the Nuremberg Chronicle (1493)

have attempted to localize Eden in the Mesopotamian Valley and elsewhere, but the results are generally regarded as more or less fanciful or speculative.

EDENTATA, the scientific name for an order of mammals, found only in the more tropical regions of America. It is considered a primitive order, and its species, which differ greatly among themselves, are among the most curious of living mammals. The sloths spend their lives suspended upside down from the branches of trees; the ant-bears have no teeth, but only long sticky tongues which are very con-

venient in ant eating; while the armadillos wear heavy armor. Sloths and armadillos have no front teeth, and their remaining ones are lacking in enamel. *See also* ARMADILLO; SLOTH.

EDESSA, an ancient city in Mesopotamia situated in the southeastern part of present-day Turkey, on the River Daisan. It is the site of the modern city URFA. Edessa's early history is vague, but it was the capital of a small kingdom until it became a tributary of Rome in the 2nd century. The Persians had a university here, and in the 4th and 5th centuries it was a seat of Christian learning, with, supposedly, about 300 monasteries. The Arabs occupied it in the 7th century and the Turks later. The city was captured by the Crusaders in 1097 and held until 1144, but was retaken by the Turks who made mosques of all the churches. Edessa was one of the four important cities of Syria. The modern city, known as Urfa, has a trade in grain and is a market for British goods. Est. pop. 1927, 40,000.

EDESSA, COUNTY OF. *See* JERUSALEM, KINGDOM OF.

EDGAR (944-975), King of the English, younger son of Edmund the Magnificent, was made King of England north of the Thames by discontented Mercian nobles in 955 while still a child. In 959 Edgar became King of all England, and immediately associated himself with St. DUNSTAN of Canterbury, who became his chief adviser. Edgar's reign was peaceful and efficient until his death in 975.

EDGEHILL, BATTLE OF, Oct. 23, 1642, the first battle of the Great Rebellion in England, between the troops of Charles I, under Lord Lindsey, and the Parliamentarians, led by Lord Essex. Each army numbered about 14,000 men; but the Royalists had greater training and experience. The first Royalist cavalry and infantry attacks were successful; but in pursuing the enemy too far the ranks were disorganized. With a strong infantry, the Parliamentarians were able to withstand and repulse further attacks. Essex withdrew the following day, leaving the victory to Charles.

EDGE TOOLS. *See* AX; CHISEL, etc.

EDGEWORTH, MARIA (1767-1849), Irish novelist, was born at Black Bourton, Oxfordshire, Jan. 1, 1767. Her home, however, was at Edgeworthstown, Ireland. *Castle Rackrent*, her first novel, and perhaps her best, appeared in 1800. After publishing her second book, *Belinda*, Miss Edgeworth wrote a number of novels, including *The Absentee*, *The Modern Griselda*, *Leonora* and her two series of *Tales of Fashionable Life*. She died at Edgeworthstown, May 22, 1849.

EDICT, a proclamation having the force of law. The Roman praetors, the emperors of Rome and the kings of France issued such edicts. They were akin to the ukases of the Russian czars.

EDINBURGH, the capital of Scotland and of the County Midlothian, situated at the entrance of the Firth of Forth. About 2 mi. south of the coast, the Old City lies among the hills, rebuilt mostly in the

16th century after a devastating fire, with many old houses of 10 to 12 stories. The old castle on a crag, once the seat of the kings of Scotland, now used as barracks, dominates the city and affords a fine view of Edinburgh and its surroundings. North of the castle is the center of the New City, built in the second half of the 18th century with wide and regular streets, imposing buildings and parks. The principal street is Princes Street between the two main stations, lined with the finest edifices, the lofty Walter Scott monument, the Royal Scottish Academy, and the National Gallery of Scotland (containing chiefly paintings of Scotch and French masters of the 19th century), banks, shops, hotels and clubs. East of the castle is St. Giles' Cathedral, built between 1385 and 1495, badly restored about 1880, with a remarkable tower dating from 1495, and a richly decorated interior. Nearby is the former House of the Scotch Parliament, 1640 and 1808, occupied since 1707 by the Supreme Court, and by the Scotch National Library since 1925. On the eastern edge of the city at the foot of the King's Park crags, is Holyrood Palace, formerly residence of the Scotch kings. To the northwest of Holyrood is Calton Hill with an observatory, a Nelson monument and the unfinished monument in commemoration of Waterloo. At the foot of the hill is the Royal High School of 1829. In the Old City are also the Royal Scottish Museum, 1866, and the Heriot-Watt Technical College. In the New City are the National Museum of Antiquities and the Scottish National Portrait Gallery. On the northern border of the New City is the Botanical Garden.

Edinburgh and its port, Leith, have almost grown together. Edinburgh is the political and cultural center of Scotland and seat of the highest officials and courts, of a bishop of the Scotch Episcopal Church and of a Roman Catholic archbishop. At the head of the city government are the Lord Provost and 42 councillors. The University, one of the foremost in Great Britain, was founded in 1583. Among the many learned societies are the Royal Institution, the Literary Institution and the Royal Society. Due to the proximity of the Midlothian coal mines, Edinburgh has many diversified industries. The manufacture of chemical and rubber products is important, as well as brewing and distilling. There are adequate railway communications and local transportation facilities, besides the steamers to numerous European ports from the harbor of Leith. The name of the city is said to date back to King Edwin of Northumbria, 7th century. The oldest part is Edinburgh Castle. It was the residence of the Scottish kings in early times, but did not become the capital and seat of parliament until about 1450. With the suburbs Leith, Newhaven, Portobello, Corlinton and Corstophine, pop. 1926, 424,600; 1931, 438,998.

EDINBURGH, UNIVERSITY OF, a coeducational institution, situated at Edinburgh, Scotland. The youngest university in Scotland, it was founded in 1583 by the Edinburgh Town Council, receiving its charter from James VI. In his honor the college was

named King James' College or King's College. The most noteworthy sponsors of the institution in the early days were the two brothers, William and Clement Little, and James Lawson. The university has gained its greatest fame through the Medical School. It has six faculties: those of Arts, Divinity, Law, Medicine, Music and Science; and Graduate Courses, Summer Classes for teachers and University Extension. In 1929-30 the institution enrolled 3,758 full-time and 615 part-time students. Women are admitted to all except the Divinity courses. The university is well equipped with laboratories, hospitals, museums and a library containing 350,000 volumes and 8,000 manuscripts. The Old College, completed in 1838 after designs by Robert Adam, occupies the site of the Kirk o' Field, where Lord Darnley was murdered in 1567. The chancellor of the University in 1930 was Sir James M. Barrie; the vice-chancellor, Sir. Thomas H. Holland.

EDIRNE or **ADRIANOPLE**, a city of Thrace, capital of the vilayet of Edirne, in European Turkey. It is situated on the Paris-Constantinople line, about 137 mi. northwest of Constantinople. The rivers Tunja and Arda here meet the Maritza, which at this point turns south toward the Aegean and forms the boundary between Turkey and Greece. Edirne, distinctly oriental, has ill-built wooden houses and narrow cobbled streets. A wall, once the fortification of the city, is now in ruins and the palace, *Eski-Serai*, in which the sultans resided before the capital was transferred to Istanbul is in a state of decay. The mosque of Sultan Selim built in the 16th century, with its four high minarets and its sumptuous interior, is still considered one of the finest Moslem temples extant.

An original Thracian town, Edirne was rebuilt and enlarged by the Emperor Hadrian and its name changed from Uskadama to Hadrianopolis. A decisive battle took place here between the Goths and the Romans in 378. The great warrior sultan Murad I captured the city from the Byzantines in 1361 and made it the first European capital of the Ottoman empire. Edirne thereafter remained the residence of the sultans and the base of attacks against Constantinople until 1453 when Mohammed II captured Constantinople from the Byzantines and transferred the seat of government to that city. Still Edirne retained its position as an important commercial and military center of European Turkey. In 1829 a treaty was signed here between Russia and Turkey. By the provisions of this treaty Turkey recognized the independence of Greece and ceded important territories to Russia along the Black Sea littoral and in the Caucasus. In the Russo-Turkish war of 1877-78 the Russian armies again entered the city despite the heroic defense by the Turks. During the second Balkan War in 1913 the Turks recaptured it from the Bulgarians. The Treaty of London in the same year ceded Edirne to Turkey. Pop. 1927, 68,279.

EDISON, THOMAS ALVA (1847-1931), American inventor, was born at Milan, Ohio, Feb. 11, 1847.

EDINBURGH



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THE FORTH BRIDGE AND THE CITY OF EDINBURGH, SCOTLAND

1. The Forth Bridge, with a cantilever span of 1,710 ft., one of the largest bridges of its type in the world, crosses the Firth of Forth near Queensferry. It was completed in 1890. 2. The city of Edinburgh seen from Edinburgh

Castle. Princes Street with the Royal Institution and the National Gallery are in the center, and in the background rises the spire of the Scott Monument, erected in 1840 as a memorial to Sir Walter Scott.

For a short while he worked as a newsboy, during his spare time experimenting on various mechanical and electrical devices. He obtained a position in the telegraph office at Mount Clemens, Mich., and soon became a rapid operator. While in this position he invented several improved devices, among them being a repeating transmitter. Soon after a better opportunity for advancement came from Boston, where he worked on a voting machine, a stock quotation printer, and later on a quadruplex telegraph system which was an improvement on the duplex system he had previously brought out. In 1879 he invented the incandescent lamp, consisting of a loop of carbonized cotton thread in a vacuum, an electric current flowing through the thread causing it to glow and give a light. Seven years later he discovered and described what is called the "Edison effect" which consists of the transmission of an electric current from a filament to a metal plate enclosed in a vacuum tube or bulb. This was among the first steps leading to the development of the RADIO.

From Boston, Edison's next move was to New York, then to Newark, N.J., finally establishing a laboratory at Orange, N.J., in 1886. Here he made improvements in the manufacture of Portland cement, brought out a nickel iron storage battery, also moving picture machines, phonographs and many other devices, besides designing and building benzol, carbolic acid and other chemical plants. During the World War, he was particularly active in working on many government problems as well as those of private companies, and is credited with having been granted over 1,000 patents, including patents on electric dynamos and telephone transmitters. After the World War, Edison devoted much of his time to finding a process for obtaining a substitute for rubber from golden rod and in 1930, he obtained patents for such a process, the commercial value of which has not been conclusively established.

Edison, because of his many inventions and the publicity given them, became very widely known, and the recipient of a large number of honors as Commander of the Legion of Honor, John Fritz Medal in 1908, American Museum of Safety Medal, Rathenau Medal (German), and in 1927 was elected a member of the National Academy of Sciences. He died at East Orange, N.J., Oct. 17, 1931.

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EDITOR, a specialist who treats literary or graphic material, prepared by others, for publication or presentation. Practically everything that involves the use of pictures or words, beyond ordinary conversation, calls for editing. In certain cases editorial work calls for original material, or the complete rewriting of other material, but the largest part of this occupation consists directly or indirectly in planning, procuring, selecting; rewriting, amending, correcting or rearranging; indicating to printers, performers or others, how to set up in type, proof-read, print, perform or other-

wise present books, articles, illustrations, plays and speeches prepared by others. The responsibilities involved may range from the mechanics of proof-reading to the determination of the policies and the planning of the contents of newspapers and magazines having millions of readers. With the growth of mass-production publication, editorial functions have become more mechanized and editorial personality has become somewhat subordinated to efficiency.

Success in this occupation still requires, however, a natural interest in writing or in presenting matter to the public; but increased specialization has made intensive training in editorial technique more necessary. Schools of journalism in universities (*see JOURNALISM, SCHOOLS OF*) and other special institutions now offer such training. The opportunities for advance in editorial work are fewer than in most professions. *See also* REPORTER.

V. J.

EDITORIAL, an article in a NEWSPAPER or PERIODICAL apparently written by its editor or his subordinate and printed as an official statement of the stand taken by that editor or his publication on any given subject. The essential of the editorial lies in the fact that it represents opinion and not news. In the United States the issues of the Revolutionary struggle gave great impetus to the prestige of the editorial. The name of BENJAMIN FRANKLIN outshines those of all other editorial writers of this period. It was, however, immediately preceding, throughout, and immediately following the Civil War that the editorial in America reached its peak. The names of HORACE GREELEY of the New York *Tribune*, DANA of the New York *Sun*, Medill of the Chicago *Tribune*, WATTERSON of the Louisville *Courier-Journal*, BOWLES of the Springfield *Republican*, and Raymond of the New York *Times* represent American editorial journalism at its highest in a day when it was the man, and not the newspaper, who spoke and to whom the people listened. That day has gone by, and the personal editor has been succeeded by a staff of editorial writers who speak for the publication and not as an individual voice.

EDMONTON, the capital of Alberta, Canada, situated at an elevation of 2,158 ft., on the North Saskatchewan River, about 175 mi. north of Calgary. The surrounding region has large dairy farming and grain-growing interests. Manufactures are attracted to the city by important and accessible coal mines, and by natural gas piped from wells 80 mi. away. Packed meats, cereal foods, flour, butter, bricks and lumber are among Edmonton's products. Although only a village at the advent of the Canadian Pacific Railway in 1891, Edmonton has the well-built provincial parliament buildings and other public works, many churches and schools, including the University of Alberta, parks covering over 800 acres, and a capacious airport. Long a trading and supply center of the northwestern Canadian fur trade, Edmonton grew up about a Hudson's Bay Company fort built in 1819 to replace an earlier defense situated 25 mi. down the river and destroyed by Indians. Incorpor-

ated as a town in 1892 and expanding largely between 1901 and 1906, it was chartered as a city in 1904. A year later it became the capital of Alberta, and in 1912 was united with the rival city of Strathcona as "Greater Edmonton." Pop. 1921, 58,821; 1931, 79,197.

EDMUND, ST. (Edmund Rich), (1175-1240), English saint and Archbishop of Canterbury, was born at Abingdon about 1175. His parents were deeply religious, and as a child Edmund declared that visions appeared to him. He went to Paris to study, and later divided his time between Paris and Oxford in study and lecturing. In 1222 he left Oxford and entered Salisbury Cathedral as treasurer, and five years later Rome appointed him to preach the Crusades in England. In 1233 he was appointed Archbishop of Canterbury, but he early incurred the antagonism of Henry III. Rome sided with the king, as did the monks of Canterbury, who had always been opposed to Edmund's appointment as Archbishop. In 1240 he retired to France. A man of saintly character and deep learning, he was politically inexperienced and unable to cope with the political difficulties which confronted him. He died at Soissy, France, on Nov. 16, 1240, and was canonized soon afterwards, notwithstanding the opposition of Henry III.

EDMUND I (c. 922-946), King of England, was the son of Edward the Elder. In 940 he mounted the throne after the death of Aethelstan, his half-brother. In the same year OLAF led a party of Danes and Northumbrians against him, and for four years neither force could subdue the other. Finally in 944 Edmund gained control, and peace was declared. The following year he subdued Cumbria and placed King Malcolm of Scotland on the throne. Edmund was stabbed to death by Liofa, an outlaw, at Pucklechurch, Gloucestershire, on May 26, 946.

EDMUND IRONSIDE (c. 980-1016), king of the English and son of Ethelred II, ruled for a short period in 1016 after the death of his father in that year. The few months of his reign are associated with his continued struggle against the Danish king, Canute, who had invaded England. The two kings had agreed on a satisfactory division of territory when Edmund died on Nov. 30, 1016.

EDMUNDS, CHARLES KEYSER (1876-), American educator, was born in Baltimore, Md., Sept. 21, 1876. He graduated at Johns Hopkins University in 1897 and taught physics in various schools until 1903, when he became professor of physics and electrical engineering at the Canton (China) Christian College. From 1907-24 he served as president of this school and from 1906-17 was magnetic observer for the Carnegie Institute of Washington in China. After returning to the United States in 1924 he was provost of Johns Hopkins University until 1927 and became president of Pomona College in 1928.

EDMUNDS, GEORGE FRANKLIN (1828-1919), American statesman, was born at Richmond, Vt., on Feb. 1, 1828. Educated in the public schools, he read law, began practice at the age of 21, and

attained distinction as a constitutional lawyer. As a Republican, he was a member of the Vermont legislature, 1854-59, was a United States Senator in 1866, and served until 1891, when he resigned to resume law practice in California. He was the author of the anti-polygamy act of 1882 which bears his name and the Sherman Act of 1890. He was a candidate for President in the Republican national conventions of 1880 and 1884. He died at Pasadena, Cal., on Feb. 27, 1919.

EDUCATION. The subject of education is treated under many separate headings, the most important being: EDUCATION, THEORY OF; EDUCATION, NATIONAL SYSTEMS OF; RUSSIAN EDUCATION; ELEMENTARY EDUCATION; SECONDARY EDUCATION; UNIVERSITIES AND COLLEGES; CLASSICAL EDUCATION; COMMERCIAL EDUCATION; CURRICULUM; ADULT EDUCATION; AGRICULTURAL EDUCATION; ARCHITECTURAL EDUCATION; ART, SCHOOLS OF; DENTISTRY, SCHOOLS OF; ENGINEERING EDUCATION; INDUSTRIAL EDUCATION; LEGAL EDUCATION; MEDICAL EDUCATION; RELIGIOUS EDUCATION; PUBLIC SCHOOLS; PRIVATE SCHOOLS; WOMEN, EDUCATION OF; SCHOOL ADMINISTRATION; EXPERIMENTAL EDUCATION; DEFECTIVE CLASSES, EDUCATION OF; UNITED STATES, EDUCATION STATISTICS; EDUCATIONAL GUIDANCE; PARENTAL EDUCATION.

EDUCATION, NATIONAL SYSTEMS OF, have developed out of the recognition that national stability and national progress depend upon a body of enlightened citizens. Plato had already recognized the intimate connection between an educational system and the form of government, and Aristotle stated that this relationship contributes to the permanence of governments. It was not, however, until the emergence of nations and of nationalism in their modern forms in the 19th century that these theses were clothed with reality. For the most part education down to nearly the close of the 18th century was dominated by the claims of the Church, whether Catholic or Protestant, to control the education of the child, claims which have recently been put forward in the Encyclical Letter of Pope Pius XI on the *Christian Education of Youth*, 1930, to the effect that "all education belongs preeminently to the Church," and that the right of the Church is "absolutely superior . . . to any other title in the national order." With the rise of public education in the 17th century the Churches entered into a partnership with the states in its provision, a partnership which has continued in many countries, e.g., Germany, Holland, England, Spain, Italy and some South American countries, down to the present. (See RELIGIOUS EDUCATION.) France, the United States and Russia are the outstanding countries in which public education has been completely laicized.

Although the traditional partnership has survived very generally up to the present to the extent that religious instruction is included in the school curriculum, the tendency in the 19th century was for the state to assume the right of providing and organizing its educational system. Napoleon had sounded the

keynote at the beginning of the century when he stated that "of all political questions that (of education) is perhaps the most important. There cannot be a firmly established political state unless there is a teaching body with definitely recognized principles." The state should, then, have charge of its own educational system to prevent disorder and change.

Primary Aims. The first object of national systems has accordingly been the preservation of their forms of government, or the cultivation of loyalty to established institutions, whether monarchical or republican. Thus when the founders of the United States were discussing the importance of public education, its aim was stated to be the development of "republican machines." The predominant aim in Germany during the 19th century was to educate the masses to become "God-fearing, loyal, self-supporting subjects," an aim which, since the establishment of the Republic, has shifted to the training of independent, active citizens of the Republic. In England the emphasis has always been on the formation of character. In France the preservation of the Republic is to be secured by providing that every child shall learn those things of which no adult should be ignorant, that is, should become a participant in the national culture of France as the basis of national solidarity. Japan aims to develop loyalty to the Emperor. Soviet Russia seeks to indoctrinate the younger generation in the principles governing the new order of society. Italy makes loyalty to the Fascist regime the end of education.

National systems of education thus differ according to the political theory dominant in each nation. This, however, is not the only factor that makes for differences. The place of the family in society, social stratification, the size and number of urban and rural aggregations, the relations between labor and capital, the relations between Church and State, the strength of a nation's social inheritance, its culture, language and literature, music and art, religion and science, common ideals and ways of living, love of country, group and national loyalties, all these are factors which differentiate one national system from another, even though the essential problems of education may be the same. The form of the control of education is another line of demarcation. Those nations in which the central government has left little place for the development of local government will have a different system of administration from those in which local institutions have played an important part in national growth and development. In the one case education is administered by an omnipotent central department; in the other, a considerable degree of freedom will be allowed to local authorities. Nor is this difference determined wholly by the form of government; that is to say, that not all centralized systems are found under monarchical forms of government nor local freedom in democracies. Thus France, Ontario and the Australian provinces are the best types of centralized administration of education, while in England the local authorities bear the responsibility under the guidance of the central authority, for the progressive

development of education. In Italy and Russia a considerable amount of freedom is allowed in such matters as methods of instruction and courses of study but is checked in all matters that bear on questions of politics or economics. Nor again is liberalism always a characteristic of democracies as is shown by the legislative control of some aspects of the curriculum, by the limits on the freedom of opinion of teachers, and by the censorship of textbooks in the United States. In other words, nations have the educational systems that they want.

Equality of Educational Opportunity. From the point of view of organization national systems may be distinguished by the extent to which equality of educational opportunity is provided. The United States, since the Revolution in theory and since the middle of the 19th century in practice, is the outstanding example of a nation which has attempted to make education free "from the gutter to the university." In general, however, the demand for equality of educational opportunity has become active outside of the United States only since about 1915. Everywhere the dominant practice has been to provide an elementary education, usually compulsory, supplemented by part-time continuation schools, higher elementary schools, and vocational schools for the masses, and secondary education giving access to the universities, and often based on special preparatory schools, for the few, selected because of ability to pay fees or for intellectual capacity. To a greater or lesser degree poor pupils of ability have received opportunities for educational advancement by means of scholarships or free tuition. No system has adopted as yet the vertical or ladder form or organization in which each branch of education is articulated with the next, as in the United States, although movements in that direction have been begun in some countries. During and since the war these movements have been launched under the name *Einheitsschule* in Germany, *école unique* in France, *escuela unica* in some Spanish-speaking countries, and secondary education for all England, the purpose of which is to provide a common elementary education for all to be followed by some form of post-elementary education for the majority up to 15, for the rest up to 18, either general, semi-vocational, or vocational in character. Sweden is one of the few countries which has already adopted such a plan.

Central and Local Systems. Guidance and leadership in education has in most countries been provided by a central authority, the Ministry of Public Instruction. Where the system is highly centralized everything down to the smallest details is prescribed from above; where some initiative is left to local authorities the central ministry may define those external aspects of education, such as buildings, length of school year, medical inspection, qualifications and salaries of teachers, and leave curricula, courses of study and time schedules to local or group self-determination. While the strongly centralized system may achieve greater uniformity and more thoroughness,

that in which local initiative is permitted shows greater flexibility and adaptation to local needs, more change, and in the end more progress. France and pre-War Prussia illustrate the first type, England and the United States the second. The absence of a central national authority and even of strong state authorities for education has in the United States thrown the responsibility for progress on the local boards and on the profession itself, with the result that nowhere has the study of education become so widespread as here. There has, however, developed an extensive interest in education in the teaching profession itself all over the world and a desire to exchange views, which has resulted since the World War in numerous international conferences and in the creation of several international organizations for the study of educational problems.

France. Education in France is administered by the Ministry of Public Instruction and Fine Arts, which with the advice of the Higher Council of Public Instruction and a staff of general inspectors prescribes all the details of the educational system which was completely laicized under the Third Republic. Religious associations were prohibited in 1904 from conducting schools. The country is divided for educational purposes into 17 academies, in each of which there is a university. The rector of the university is responsible, with the advice of an academic council and academy inspectors, for the administration of education, especially higher and secondary, in the academy. The administration of elementary education and the preparation of teachers is entrusted to the 90 departments, each under a prefect who for educational purpose is assisted by a council and academy and primary inspectors. Although more authority is assigned to the communes in elementary education, the lay public as such has very little influence or representation. Elementary education is compulsory from 6 to 13 and may in some areas be preceded by the *écoles maternelles* for younger children.

The vast majority of French children have little more than elementary education. Beyond this opportunities are available in part-time schools; higher elementary schools, three or four years; vocational schools of varying length, and secondary schools, *lycées*, or state schools, and *collèges*, or communal schools, giving a seven-year course. The number of scholarships in post-elementary schools has recently been considerably increased, and since 1930 tuition fees have begun to be abolished in the secondary schools. Every stage of education concludes with an appropriate certificate granted by the Ministry; the highest, admitting to the universities, is the *baccalauréat*, the leaving examination of the secondary schools.

There is a strong movement to bring all aspects of education under one National Ministry and to reorganize the whole system on the basis of the common school, *école unique*, with a common foundation leading to increased opportunities for some form of secondary education, more differentiated than at present. In 1927-28 there were enrolled in the *écoles matern-*

elles, public and private, 361,690 pupils; in the elementary schools, public and private, 3,911,354; in higher elementary schools, 78,641; and in the secondary schools, 169,186; the enrollment in the 17 universities was 64,531; about 95,000 students were enrolled in vocational schools of different types. The national budget estimate for education in 1930 was 2,925,903,562 francs, or about \$117,040,000.

Germany. In Germany a number of reforms were introduced by the Constitution of 1919, which provides among other things that (1) neither pupils nor teachers be required to take or give religious instructions, and secular schools may be established; (2) all children must attend a common foundation school, or *Grundschule*, for the first four years of their education; (3) teachers must be prepared in institutions of university level following graduation from a secondary school. The administration of education is left to the states, with opportunity for consultation among themselves through a Federal committee on education. The organization of the administrative system in the states has remained almost unchanged; but its system has been completely reformed in the direction of permitting greater freedom to teachers and localities. At the head of each state is a Ministry, for example, in Prussia, of Science, Art, and Public Education, with general supervision of all educational and cultural activities.

Full-time education is compulsory from 6 to 14* and part-time up to 18. For young children the provision of care institutions, nursery schools and kindergartens has been increased. All children attend the *Grundschule* up to 10, private schools for this period being gradually abolished, and thereafter continue for four years more in the elementary school, or for six years in the middle school, or for six or nine years in a variety of secondary schools leading at the end of nine years to the leading examination, *Abiturientenprüfung*, giving access to the universities. By scholarships and reduced fees educational opportunities for poor but able pupils have been increased, and able pupils who remain in the elementary schools may continue through a new secondary school, *Aufbauschule*, to the university level. For vocational training Germany provides a richer variety of institutions than most other countries. Elementary school teachers now receive their preparation on a university level lasting two or three years. The total enrollment of pupils in 1926-27 in public elementary schools was 6,661,793 and in private 36,991; in continuation and trade schools 2,507,294; in middle schools 259,300; in secondary schools 821,286. In the universities the enrollment in the winter semester of 1929-30 was 103,811 and in technical high schools 27,767. The total estimated cost of education for 1926-27 was 567,155,600 RM. or \$141,788,400.

Great Britain. English education is characterized by variety and freedom. A national system as such has been in process of development only since 1902. Education is thus provided in a large number of private schools, in schools provided by denominational

groups, and in public schools, attended by the majority. Private schools may receive state and local aid under certain conditions. Denominational elementary schools, non-provided schools, were incorporated in the public system in 1902. The central authority, the Board of Education, exercises general supervisory powers and exerts its influence through grants, regulations, inspection and suggestions, without prescribing the details of what shall be taught in the schools. The responsibility for the progressive and comprehensive development of education is imposed on the local authorities through the education committees of the local elected councils, whose powers vary with their size. Counties and cities of over 50,000 population may provide any type of education; other areas are limited to the provision of elementary education.

Under the Acts of 1902 and 1918 there has been a rapid development of public education from the nursery school up to but not including the universities, which are autonomous. This includes the provision not only of schools but of a variety of social and medical services for school children. Compulsory education extends from 5 to 14; a bill to raise the age to 15 was defeated in the House of Lords in Jan. 1931. The majority of children attend the elementary schools; at about the age of 12 opportunities are afforded for abler pupils to proceed to central, or higher elementary, schools, which are free, or to secondary schools in which nearly 40 per cent of the pupils receive free tuition. There is a movement to reorganize the whole system into primary education up to 11 plus, to be followed by some form of post-primary education to 15, leading up to advanced secondary education. An inquiry into private schools, whose number is not known, is now under way.

The enrollments in England and Wales in the various schools reported by the Board of Education in 1930 were as follows: nursery schools, 1,826; elementary schools, 5,546,002; secondary schools, 394,105 in grant-earning schools, and 64,969 in recognized but not grant-earning schools; continuation and vocational schools, 27,479 full-time and 941,244 part-time students; universities (1928-29) 36,814 students. The estimates for government expenditures for 1931 were £48,362,377 for education in general and £1,830,000 for universities; these figures do not include the expenditures of the local authorities.

The United States. The chief characteristics of education in the United States are the provision of educational opportunities for all and the vertical organization of the system which eliminates the overlapping of school types found elsewhere. The Constitution by implication left the provision and administration of education to the states, which in turn have in many cases delegated powers to local groups, as cities, towns and counties. A Federal Office of Education is maintained; but its chief functions are to collect statistics, to disseminate information and to administer education in Alaska. The Department of Agriculture administers several funds for agricultural

and homemaking education, and the Federal Board for Vocational Education funds for vocational education. For some time there has been a movement to consolidate the educational activities of the Federal Government in one Department of Education under a Secretary with a place in the Cabinet. The whole question is now being considered by a National commission.

The major responsibility for the conduct of education thus devolves on the states through their legislatures, boards of education, and superintendents, the majority of whom are still elected officials. The states lay down the general requirements for financing education, compulsory attendance and minimum length of the school year, the broad lines governing the curriculum and courses of study. There is, however, no uniformity in the powers allotted to or exercised by the state authorities. As a general rule it may be said that education in the United States has developed largely out of the local district systems which often jealously guard their rights; but the tendency at present is in the direction of developing larger units of administration. Largely because of the absence of strong central authorities agencies for the professional study of education, bureaus for educational research, and educational foundations have contributed largely to the improvement of education, and a group of professionally trained administrators has emerged. (*See SCHOOL ADMINISTRATION.*)

Since education is so largely a local affair no other country has adopted such extensive schemes for educating the public, which pays for it, to appreciate its importance. It follows from the same cause that there is no uniformity of practice or quality in education throughout the country in such matters as length of compulsory attendance and school year, equality of educational opportunity especially in rural areas, qualifications and salaries of teachers, curriculum organization and courses of study, standards of achievement, and quality of instruction. The whole enterprise is so vast and the opportunity so great that the best systems are always marking out the way of progress. The only common feature is the vertical organization which provides a progressive articulation of schools from the elementary through the high schools to the university. The general scheme provides for eight years of elementary education, preceded in some places by kindergartens, four years of high school education, and four years of college followed by graduate study in the universities. A more recent tendency is to divide the system into six years of elementary, three years of junior high, and three years of senior high school followed in some places by two years of junior college. A later proposal is to divide the system into six years of elementary education followed by two four-year periods to the end of the junior college. There is thus constant unrest and experimentation in every possible phase of education. The preparation of elementary school teachers is also passing through a transition period, advancing from two years of normal school beyond high school gradua-

tion to three- and four-year teachers colleges, although lower standards than these are still accepted for rural teachers. *See also* PUBLIC SCHOOLS; UNITED STATES, EDUCATIONAL STATISTICS; UNIVERSITIES AND COLLEGES; RUSSIAN EDUCATION. I. L. K.

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EDUCATION, THEORY OF. The function of a theory of education is to determine and define the aims and purposes of education. Since man is a social and political animal and since the life of the individual derives its meaning and values from his relations to his environment, including man and nature, education may be broadly defined as any change produced in the habits, attitudes, behavior, skills and knowledge of the individual through his actions and reactions to this environment. Thus all experiences of the individual are in a sense educative, since they produce changes and modifications in his conduct. The term education is, however, definitely restricted to that formal process which society institutes for the deliberate purpose of guiding, training, or even molding its immature members in a certain direction. By an extension of the process the mature person may be said to be educating himself when he sets out purposefully and deliberately to acquire experience for himself. Education in the first, informal sense has been defined by John Stuart Mill as "whatever we do for ourselves, and whatever is done for us by others, for the express purpose of bringing us somewhat nearer to the perfection of our nature; it does more; in its largest acceptation it comprehends even the indirect effects produced on character, and on the human faculties by things of which the direct purposes are different; by laws, by forms of government, by the industrial arts, by modes of social life; nay, even by physical facts not dependent on human will, by climate, soil, and local position." The formal process of education is thus based on the recognition of the educability of human beings, which differs from the educability of animals to the extent that the human being can recall, can generalize and rationalize, and can apply experiences to new situations.

Factors Involved in Education. The process of education accordingly involves three factors: (1) environment or experience which in informal education are unselected and indiscriminate but in formal education purposefully selected or arranged; e.g., the curriculum and courses of study selected with a deliberate aim or purpose in view; (2) the pupil or student or educand to be educated; and (3) the interrelations and

interactions between these two, i.e., the methods of learning and instruction. Hence arises the question whether theory of education is an independent field of study or whether it is dependent on others. Obviously when it seeks to define aims and purposes and on the basis of these to determine the nature of the environment or experience which the educand is to acquire there is at once raised the question of the purposes of life and the nature of experience. Educational theory is dependent for answers to these questions on philosophy, or ETHICS and METAPHYSICS. For a long time in the history of education, and still very extensively, aims and purposes have been and are dominated by answers supplied by religion. (*See* RELIGIOUS EDUCATION.) Since the formal process of education is an instrument organized by society to modify the conduct of the immature individual or the oncoming generation, a theory of education is inevitably confronted with the necessity of inquiring into the nature of society, and must lean heavily on the social sciences, and since the largest unit of society is the State, political theory which discusses the nature of the State and the relation of the individual to it must be drawn upon to provide a basis from this point of view for aims and purposes. (*See* EDUCATION, NATIONAL SYSTEMS OF.) Education being a process of modifying the individual or the educand, educational theory depends on a knowledge of the nature of the individual: what he is, his possibilities as a human being and as a person, the methods of his reactions to environment or experience or how he learns. Hence biology, physiology and psychology, individual and social, constitute fundamental bases for a theory of education as well as for methods of instruction.

It is true that the question whether the theory of education is a science or an art cannot be answered unequivocally. From certain points of view it is an art. Its character as a science depends on the scientific character of the ancillary fields of human knowledge from which it derives its data. The tendency to-day is to leave less and less to metaphysical speculation, certainly so far as the nature of the individual is concerned, and to become more and more scientific in the bases upon which educational theory relies. (*See* EXPERIMENTAL EDUCATION.) And yet since its main function is to define purposes which depend upon fields of knowledge that are speculative and dependent upon opinion and subjective interpretation and since its ultimate goal is to affect practice, educational theory is an art, a practical philosophy of life. Because education is as broad as life, its purposes will vary with whatever ideals of life may prevail. Because philosophers differ about the nature of experience and ideals and their interpretations may be at one period idealistic, in various ways, or materialistic and mechanistic, or instrumental, educational theory changes with changes of interpretation. Because the nature and relations of the State to the individual vary at different times and in different countries, another factor which makes for the imperma-

nence of educational theory enters. Education is accordingly both a science and an art, but it is a science only in a limited sense, and, while the so-called scientific movement in education of the last 25 years is making an important contribution to theory, this contribution can at best be but partial.

Historical Development. The history of education is devoted to a record of changing educational theories and of the practices dependent upon them. One fact stands out clearly and that is that throughout history society, that is the adult generation, whatever the form of its organization, has always sought through the educative process to transmit to the next generation its own knowledge and information, its skills and practices, its customs and conventions, its ideas and ideals, in a word, its cultural inheritance. The first task of education, in other words, has been the transmission of this inheritance for the conservation and preservation of society itself. This aim has dominated primitive societies and continues in a large measure to dominate the most civilized societies. In so far as educational theories have changed, the changes have been due to attempts to define the cultural purposes of societies and the methods of transmitting them. And because the transformation of social aims and ideals have been so slow as to be almost imperceptible before it can be said that a new era has appeared, there has always been a gap between social and cultural changes and changes in educational theory. One result of this fact has been that school practices have always lagged behind the already recognized needs of social change. A further result has been the tendency to adopt formal, stereotyped patterns in the school and to justify them on rationalized bases rather than in terms of social need. The development of educational theory represents a slow but gradual attempt made from time to time to bring it into harmony with recognized social and cultural change.

Education and Social Progress. The gradual emergence of education as a field of study in its own right, even though dependent still on a number of ancillary studies, and the widespread recognition of education as a tremendous social force has emboldened educational theorists of to-day to go beyond the traditional concept of education as the transmission of cultural inheritance and to put forward the claim that the purpose of education is the promotion of social change and social reconstruction. There thus emerges another purpose of education which consists not merely in training the younger generation through the cultural inheritance to become adjusted to the environment but to give it the tools and techniques both for controlling and reconstructing it. This means an attempt to avoid the traditional gap between the school and the society and to enlist the school in the interests of social progress. The school must be an agency not merely for transmitting the experiences of the past as a preparation for living in the present, but through an analysis of present needs and trends toward the future for preparing for the social changes

so indicated. This method of approach raises in turn the vital and permanent problem of the nature of society, the State, and the individual, and the whole question of determinism and freedom in education and social life in general.

The characteristic of education, however, is that unlike pure sciences it is not its own concern. It is and always has been an instrument of society, an instrument in which all elements that make up society are concerned, the family, the church, vocations, and the State, to mention only a few. Accordingly there have always existed certain popular expectations or ideas about the aims of education, which create a certain amount of resistance to new theories, but which the educator must take into account. The most widespread popular concept is that the aim of education is to impart certain knowledge and skills to the younger generation. This concept is based on the general beliefs that knowledge is power and that knowledge is the basis of moral conduct. One result of the first belief has been that the chief, almost the sole, function of the school is to provide for the acquisition of knowledge. Belief in knowledge as power for nearly three centuries, from the 17th to the 19th, tended to load the schools with an almost encyclopaedic mass of information, some useful, most of it unselected and indiscriminate. It was in an attempt to correct this situation that HERBERT SPENCER discussed the problem, What knowledge is of most worth? Defining education as preparation for complete living, Spencer concluded that worthwhile knowledge must deal with "(1) Those activities which directly minister to self-preservation; (2) those activities, which, by securing the necessities of life, indirectly minister to self-preservation; (3) those activities which have for their end the rearing and discipline of offspring; (4) those activities which are involved in the maintenance of proper social and political relations; (5) those miscellaneous activities which make up the leisure part of life, devoted to the gratification of tastes and feelings." While the value of knowledge as essential for the promotion of human welfare is admitted, all knowledge is not useful in the first place; and, secondly, in order to be useful it must be acquired in such a way as to be meaningful and functional. Hence educational theory to-day refuses to accept the mere acquisition of knowledge, unselected as to functions and purposes, as the sole aim of education.

Education and Knowledge. Equally traditional and widespread is the belief that knowledge is the basis of morality or, as Plato said, that "virtue is knowledge." The Roman theorists formulated this in the words *abeunt litterae in mores*, or knowledge works over into morality. It was on the basis of this belief, too, that Guizot formulated the slogan, widely accepted in countries outside of France, "Open a school and close a jail." Literacy, in other words, was regarded as the best panacea for all social ills. Practically the world has seen that mere knowledge does not produce moral conduct, and with a few outstanding exceptions, as in France and Japan, the direct

teaching of morals is not accepted as sound. Discrimination between right and wrong is undoubtedly based on knowledge; but moral conduct is derived from actual situations that call it forth and lead up to a realization or knowledge of the principles involved. The influence of knowledge on character, however, has not been confined to popular belief. Plato recognized the influence of a knowledge of literature on character when he expressed his opposition to the teaching of fairy stories and myths to children. Vittorino da Feltre stressed the importance of careful selection of literature because of its moral influence, a view which has prevailed to the present day. The whole theory of JOHANN HERBART is based on the notion that character is formed by the proper selection of what is taught to the young; ideas are based on knowledge and ideas make the man. The criticism of these theories is that knowledge in and by itself does not exercise any strong influence either on molding character or as power unless it is deliberately directed to these ends; otherwise it is accumulated only as a store.

Education as Preparation for Life. Another popular definition of education is that it is a preparation for life, that childhood and youth are the periods in which are acquired knowledge, skills, habits and attitudes that will enable the individual to live happily and fruitfully as an adult. Milton's classical definition was that "a complete and generous education is that which fits a man to perform justly, skillfully, and magnanimously all the offices, both private and public, of peace and war." The criticism of this concept is that it imposes on the child adult standards and knowledge whose values are understood by the adult but not necessarily by the child. A study of child psychology and of child interests has led to the substitution by John Dewey for this concept of the principle that education is not a preparation for life but is life itself, not a process of getting ready for the future but of rich and happy and purposeful living at each moment of life; all stages of the educative process are contributory and have values both immediate and preparatory to the next stage. One might well ask when life begins according to this statement of aim. On the other hand if education is life, it is an ongoing process continuing as long as life, a fact which with the progress of adult education is becoming increasingly recognized. (See ADULT EDUCATION.) By some the aim of preparation for life is even more limited to preparation for making a living, a statement which is always met with the objection that man does not live by bread alone, an objection which gains all the more ground with the progressive reduction of the hours of labor and increase of the time available for leisure.

Education and Mental Discipline. When it does not define education in terms of knowledge or preparation, popular opinion may define it in terms of mental or intellectual training or discipline, a definition which is not limited to the layman but has been current among educators certainly from the time of

JOHN LOCKE at least. The general concept underlying this aim is that it does not matter what the content of education may be or what the pupil learns, provided that if it is properly selected it trains the mind, just as hard physical exercise trains the body. Certain subjects or aspects of subjects, the more formal the more effective, as Latin and mathematics, for example, were regarded as better disciplines than others. This concept was so abused that Mr. Dooley, the American humorist, could say, "It does not matter very much what the children learn, so long as it is disagreeable enough," which is another form of a criticism passed on the school nearly 2,000 years earlier, *scholae non vitue discimus*, or we learn for school, not for life. The disciplinary argument is one of those rationalizations created to justify in education the retention of content that has ceased to function and become formal. The doctrine of formal discipline, however, also involves the notion of transfer of training, that the mind trained by one subject is strengthened and functions in other situations. This doctrine was questioned by German and American psychologists at the end of the 19th century, and experiments have proved that the transfer values of subjects *qua* subjects is slight and not automatic, and in any case it can take place only under certain conditions of identity of content and methods. Further the doctrine of formal discipline was posited on a faculty psychology, that the mind consists of a certain number of faculties. This psychology has now been discarded as without basis in fact. One result of the defective psychology and of the doctrine of formal discipline, which implied that the educative process involves effort on the part of the learner, was the attempt to overcome the initial difficulty confronting the learner in a new situation by making it interesting. Instead of discovering the intrinsic interests of children, the doctrine of interest implied that subjects or situations otherwise uninteresting could be made interesting by the proper selection of methods of instruction. Herbart's contribution to education consisted in the main in the formulation of such methods, which were crystallized by his followers into the Five Formal Steps. But this contribution did not eliminate the objection that the content of education still remained formal and extrinsic to the learner, that it was not of itself interesting, that it still involved effort of an external type and its correlative external rather than self-discipline.

Education and Harmonious Development. To offset the danger that the doctrine of formal discipline and transfer tended to limit the educative process to a narrow round of subjects and restrict it to the development of a restricted number of activities, another aim of education was proposed: that education must prepare for the harmonious development of all one's powers for complete living. Herbert Spencer's selection of the most essential activities of life has already been mentioned. Like the perfection of all one's power, they do not answer the question of what is meant by complete living. They ignore the existence

of individual differences; and they neglect the importance of specialization.

The Present Problem. A number of other theories might be listed as they have developed in the history of education, but it will be found that all of them are defective. They ignore the nature and needs of the individual and his relations to society and the state. They neglect to discuss the nature of society and the state and their claims in the educative process. They are posited on the acceptance of a fixed conception of culture to be transmitted. And from whatever point of view they are approached they tend to remain partial. To some extent, however, changes have taken place both in the content and in the methods of education, the former responding to changes in civilization and the expanding scope of human knowledge, the latter in order to secure more efficient mastery but based somewhat on speculation and on faulty psychologies. In all cases the history of educational development has been marked by dualism: the individual and the State, school and society, interest and effort, the learner and the curriculum, subject-matter and method. The tendency in the development of educational theory in the last 30 years has been to eliminate these dualisms and to incorporate into it the implications of the theory that education is life. In so far as conflicts still remain they rest in the main on the philosophy of experience and the philosophy of the relations between the individual and society. Of the two the problem underlying the latter is the older.

Control of Education. The permanent question in education has always been, "Who shall have the control of the education of the child?" Aristotle already said, "Of all things that I have mentioned, that which contributes most to the permanence of constitutions is the adaptation of education to the form of government," and, "We laid it down that the end of politics is the highest good; and there is nothing that this science takes so much pains with as producing a certain character in the citizens, that is, making them good and able to do fine actions." During the Middle Ages education was controlled by the Church, which continued as a partner in the educative process when, after the Reformation, the State undertook its provision. The theorists of the French Revolution enunciated the principle that the child belongs to the State, a point of view that was adopted by the founders of the American Republic, who argued in favor of public education in order to create "republican machines." The basis of the French system of education rests on the acceptance of this principle, that, according to Napoleon, "there cannot be a firmly established political state unless there is a teaching body with definitely recognized principles. If the child is not taught from infancy that he ought to be a republican or a monarchist, a Catholic or a free-thinker, the State will not constitute a nation; it will rest on uncertain and shifting foundations; and it will be constantly exposed to disorder and change." This principle, that the child belongs to the State and that

it is the function of the State to control the nature and character of his education, that is, to mold him according to a desired pattern, became firmly rooted with the growth of national states in the 19th century. It was Germany perhaps better than any other country, which, dominated by the philosophy of Hegel, expressed this principle in practice on the ground that the State alone, as an idealized entity above the individuals that make it up, has a mission and destiny to fulfill and has, therefore, the right to organize that education that will realize its *Kultur*. England continued to be the outstanding example of the National State that exercised the minimum of interference with education, but here definite patterns or molds were set up in part by the homogeneity of the population, in part by the denominational groups which for a long time were the chief agencies for the provision of education. In the United States the dependence of public progress on education and enlightenment has always been recognized; but, although the spirit of educational provision was democratic, its practice was for a long time dominated by theories borrowed particularly from Germany. To the extent that education is dominated by political and nationalistic ends, educational theory must accept readymade purposes defined for their realization. Thus the emphasis on a clearcut definite conception of culture which dominated the French State led to the formulation that for the masses the function of the school is to teach those things of which no adult should be ignorant, a static conception of society and of the curriculum based on the idea that the individual is to be molded to a particular pattern. The impact of political theory on education is nowhere better illustrated than in the recent tendencies in Italy under Fascism and in Russia under Bolshevism to subordinate the individual wholly to the State. Even in the United States the states have in many instances assumed the right to prescribe and dictate what shall be taught in the schools and to censor textbooks. From the point of view of educational theory these claims of the State to dominate the educative process are based on the fundamental principle that the first function of education is to transmit the cultural inheritance for the preservation of the State.

The Individual and the State. A profound change has, however, been taking place in the political conception of the place of the individual in the State since the World War. The keynote of educational progress lies in the acceptance of the ideal of democracy, not merely as a form of government but as a form of associated living. This ideal implies the recognition of the worth of the individual and of his potentialities for his fullest development consistent with his ability and a realization of his social responsibility. To develop the individual according to a pattern which it pleases a government to mold is not enough to release his abilities. To develop him as a personality conscious both of his rights and duties, of his place in his own groups, in his country, and in the world is to-day the great task to which nations

that are being built up on the ideal of democracy are addressing themselves. In the light of this change educational theory is finding fuller scope for its development. The stability and progress of nations, it is now recognized, depends, not on molding the individual to a pattern but on providing free scope for his fullest development in accordance with his abilities.

Nature of the Individual. The statement has already been made that in any theory of education one of the elements in the process is the individual who is subjected to it. The general tendency at the present time is to stress the importance and worth of the individual and to recognize that individuality is the ideal life. Biologically it has been proved that the essence of life, in the lowest as in the highest animals, is a striving or urge toward individuality. The function of education, then, is to assist this striving and to direct it in a right direction which is determined in part by the nature of the individual and in part by the environment in which his individuality is to find scope for its attainment. What then is the nature of the individual? For many centuries education was dominated by the belief that original nature is base, that is, by the doctrine of original sin, and that the function of education is to mold and bind and discipline the individual in order to save him against his worse self. This doctrine was accompanied by another, that true happiness cannot be found in life on earth but in the life hereafter. A new note was struck however by Rousseau, who insisted that everything is by nature good and that it is civilization that makes it bad. Hence education must respect nature and follow the laws of natural development and the trend of natural inclinations. This idea, of tremendous significance for the development of education in the 18th and 19th centuries, has had a latterday revival in certain interpretations of and experiments with the doctrines of freedom and growth in education, the essence of which is that there must be no external interference with the natural development of the child's interests, that through the more or less undirected contact with his environment the child will grow into a normal member of society. This aspect of educational theory will be discussed again later.

The character of the original nature of man has been subject to other interpretations, which may be reduced to the question whether environment or heredity is the greater influence in the development of man. The environmentalists hold that original nature is neither good nor bad, that it is a neutral mass of protoplasm, that man comes into the world as a plastic piece of clay, and all differences which arise between one individual and another are due to the impact upon him of his environment or, in a more formal way, of his education. Those who attribute the chief influences to heredity hold that everything in the way of potentialities and capacities already exist in the individual by original nature when he comes into the world, and that environment or education furnish only the means for calling them

forth and developing them. All individuals *qua* human beings are born with the same tendencies to act; differences between them are due to differences of immediate heredity. The conflict between the two schools of thought, the environmental and the hereditarian, manifests itself to some extent in the amount of reliance which each places on intelligence tests. One group claims that there is no absolute, deterministic measure of intelligence but that what is measured is in large part the result of education, formal and informal. The other insists that the intelligence tests measure native ability.

The present situation on this topic, based on the results of researches in psychology, physiology and biology is that original nature is neither entirely neutral, that is wholly subject to environmental influences, nor so endowed that it will develop spontaneously if left to itself. In other words the development or growth of the individual is determined both by his original nature and by his environment. As a human being the individual is born with certain tendencies to act, with certain urges or drives, with certain potentialities and capacities which are part of the human structure but which need an environment to bring them out. Nor are these tendencies and other forces ready to act immediately or at the same time. Most tendencies are shared by all normal individuals as part of the original nature of the human being. Potentialities and capacities vary in quantity, quality and intensity according to his immediate heredity. Hence the task of education is to study the individual and provide the proper environment for the realization of his self as a personality. The general implication of modern theory is, therefore, that original endowment will not develop without the proper stimulus to develop it. But the task of education is broader still; its function is not merely to encourage or strengthen some tendencies, but also to modify some and to eliminate others. The development or growth of the individual involves the cooperative interplay between original nature and environment, between nature and nurture.

Such cooperative interplay is possible because individual nature is modifiable. It is the native ability of the individual to react to stimuli that makes him educable. At the lower level this reaction is determined by his response to pleasure and pain, to satisfiers and annoyers rising to a higher level of ability to discriminate between right and wrong, to be conscious of standards and values, to make choices, to think and to reason. Individual development is not merely self-expression which implies a self already made, but the gradual building up of a self or personality; self-realization rather than self-expression, since self-realization implies a goal or an ideal which becomes richer and greater as the individual develops.

Education and Growth. For education this principle of growth or development is full of meaning and significance. It implies that the starting point and center of the educative process is the individual whose growth is determined by his reaction to experi-

ence or environment. Hence education is not pouring in or cramming of knowledge or information, even though it be made interesting by technical or methodological devices. Nor does it deal solely with the intellectual development of the individual, but must give due play to his emotions and will. The individual thus represents the unit in the educative process which provides him with the opportunity of developing by means of a variety of diverse experiences. Self-realization or the integration of personality is the process of cultivating unity through diversity. But the development of the individual is meaningless without a goal or purpose. Indeed, the very acceptance of the notion of individuality is made possible only by the existence of other individuals, by membership in a society of some kind. The individual may be born with a tendency to vocalization and facial expression, but neither language nor expression can develop if the need for intercommunication, for language, were non-existent. In other words the goal or purpose of self-realization or the cultivation of personality is not determined within the individual by original nature, but is furnished by the fact that he is a member of society. The fact he is born a social animal renders possible his gradual socialization.

The Individual and Society. The State or society, said Aristotle, is prior to the individual. This does not necessarily mean that the individual is born to be dominated by the State or by society but that all the institutions which go to make up the society precede the individual and provide the environment which calls forth his innate tendencies to action. He is born a member of a family, a group, a variety of social organizations; he is surrounded by all the institutions (language, skills, knowledge, conventions and customs, morality and religion, economic life, government, culture and civilization) which human society has developed for its own preservation, advancement and progress. These constitute the sources of experiencing which furnish for the individual opportunities for growth and self-realization. The problem with which educational theory has always been confronted is whether these institutions, to which the individual is to be adapted, are fixed and unmodifiable, or whether they are ongoing processes in the expansion of which the individual through the development of his own personality and his interrelations with other developing personalities contributes. As has been already indicated in discussing the relations of political forms to education, the acceptance of the first concept of the fixity of institutions implies one form of education, a form in which the chief task of the educative process is to mold the individual to a particular pattern of conduct and ideas, to somewhat limited objects of allegiance, permitting growth or development within recognized limits only. Such was the type of education in pre-War Prussia, and is the type in Russia and Italy to-day. The acceptance of the second concept implies not merely that society and the individual exist for each other, but that the task of education is to develop him as a responsible

agent, responsible not merely for his own realization but for the realization of the best potentialities of the society of which he is a member. In a sense education under the second concept inevitably involves adaptation or adjustment to society in so far as there is an innate tendency to take over modes of behaviour, thoughts and feelings from one's fellows, and socialization is based on a desire for social approval or disapproval. But the difference lies in this, that in the first instance adaptation takes the form of direct indoctrination, compulsion through discipline and authority, while in the second the individual is treated as a living, creative, self-determining organism seeking not merely to adjust himself to his environment but mastery over it. This is what is meant by the statement that true democracy has begun to recognize the worth of the individual, not merely political equality before the law but potentialities to be developed and responsibilities to be fulfilled. Hence the basis for education is not a fixed quantum of knowledge but opportunities for contact with a wide range of socially desirable experiences. The dualism between society and the individual, between school and society, between the individual and the curriculum is resolved by the recognition that both aspects are parts of the same ongoing process. "The social environment," says John Dewey, "consists of all the activities of fellow-beings that are bound up in the carrying on of the activities of any one of its members. It is truly educative in its effect in the degree in which an individual shares or participates in some conjoint activity." The continuity of the individual and society he further describes in the statement that "the social environment forms the mental and emotional disposition of behaviour in individuals by engaging them in activities that arouse and strengthen certain impulses, that have certain purposes and entail certain consequences." There is thus, according to this view, a unity between individual and group experience. The problem involved in education is accordingly how the individual enters into social experience.

Meaning of Experience. Experience may be defined as whatever happens to the individual or what he does, the totality of human activity. The individual in experiencing may be active or passive; that is, he may be the subject or object of experience. Further, experience is not limited to the conscious but, as the psychoanalysts have shown, may be unconscious and still exercise a considerable influence on the development of the individual. Since experience includes all human activity, all the interrelations between the individual and his environment, it includes all sensory, perceptual, motor and emotional activities. By virtue of its definition experience is not atomistic, a mere bundle of happenings, but is an ongoing, continuous process with unity given to it by the individual who experiences it. Because it is ongoing and continuous experience is the basis of other experiences and gives them meaning; the individual reacts in terms of his previous experience. The criticism which is passed on traditional educational practices is first

that they have emphasized only one aspect of experience, knowledge, which is itself the organized experience of the race or of other individuals; that only rarely has it provided adequate opportunities for emotional and motor experiences; secondly, knowledge itself has been imparted in an atomistic piecemeal fashion, selected in terms of ends and aims extrinsic to the individual, that is, unrelated to his experience. In a sense the Herbartian philosophy and method attempted to correct this situation, but it laid too much stress on the potency of ideas or knowledge alone and adapted an external organization on a school content which continued to be unrelated to experience, or had to be made "interesting." The emphasis on knowledge as the only significant type of experience of value resulted in such distinctions as between "knowing" and "doing," "culture" and "utility," and so on, distinctions which further disintegrated the experience of the individual.

Education and Experience. The characteristic of the human organism, endowed with impulses, drives and tendencies to action, is to reach out for experiences and to be in turn influenced and modified by them. In this sense the aim of education is to change behavior, since all experience may produce differences in habits, attitudes and ideals of the individual. Experience may at first be crude, immediate, direct; but the function of education is to train the learner to organize and systematize these experiences into knowledge and science and at its highest stage into philosophy. In other words the learner is to be trained in methods of thinking, which means the relating of new experiences to old, the modification of meanings in the light of the new. It means further the experimental attitude and suspension of judgment until the whole range of an experience has been verified. When organized, experience becomes the starting point for new experience and is to that extent an instrument of control which projects itself into the future. Since the individual is endowed by nature with certain tendencies to action, he already has the readiness for experience. Accordingly the learning process involves as its first step readiness or awareness of need or recognition of a situation to be met or solved. Whether the learner will continue with the process depends on the effect of the new experience, that is, whether it is pleasurable or painful, satisfying or annoying. Whether he will learn anything from the process or organize his experience depends on its repetition. This simple statement does not, however, explain the whole learning process; although it is the definition of the process, it explains learning only at the lower levels and rests on the assumption that learning or thinking is dependent solely on first-hand, direct, immediate experience, an assumption which would for education be extremely wasteful of time. There is also involved the further assumption that all experiences must be immediately satisfying or pleasurable and that their ends, or meaning, or purposes must be foreseen at once. The definition neglects the important fact that one of the important

ends of education and the result of desirable experiences must be the emergence of ideals. Immediate satisfaction or success is not an adequate guide. Continuity, persistence, perseverance in thinking and learning are perhaps more dependent on the emotional results of experience, that is, ideals and standards of value which are often more potent than the immediate recognition of problems. The danger which inevitably accompanies the partial statement of the learning process in terms of readiness, effect and repetition is the acceptance of soft pedagogy or the primrose path.

The definition of education in terms of experience rather than in terms of knowledge, facts and information has the advantage of concentrating the process on the individual and the totality of his needs and activities. Experience is broader than knowledge and when organized, rationalized and understood becomes an instrument for further experience and control; that is, it becomes active and a guide of life. Education, then, becomes, in the words of John Dewey, "the reconstruction or reorganization of experience which adds to the meaning of experience and which increases ability to add to the course of subsequent experience"; not mere mechanical absorption but a creative process, that is, creative in making over the individual.

The Learning Process. By definition all experience, good or bad, modifies behavior, and all education is experience. The problem of a theory of education is to guide the individual toward desirable experience. Since education is an institution created by society, even the most primitive, for the promotion of certain ends and since the individual is a social animal, education is concerned with the discoveries of those social values, standards and ideals which society at any time regards as desirable. The permanent aim of all societies has always been the transmission of that culture, that knowledge, those skills, habits, attitudes and ideals which it has found essential for its own preservation and which it desires to hand on to the next generation to enable it to continue. Societies or groups in societies may, however, be static, that is, they may be content with a fixed, unchanging culture. Or they may be dynamic; that is, they may utilize inherited culture for projecting themselves into the future. In the first case transmission is mere indoctrination, imposition on the individual by coercion of an inherited culture which at one time was meaningful but which for the individual may appear to be sterile and barren. In the second case the inherited culture may continue to be transmitted; but the experience of the individual is utilized as a basis for its acquisition. It becomes his own to the extent that he recognizes its meaning for his own life and the life of society; and it is used as the basis for reaching out for new experience. In other words, the individual becomes an active agent in his own education, and education becomes something more than instruction.

Education and Life. The difficulty with which education is confronted to-day is the increasing com-

plexity of modern civilization due to the rediscovery of the world through science, to changes in forms of government and in the meaning of democracy, to changes in attitudes to religion and morals, and particularly the transformation of the world through the new machine age, the expansion of means of communications, and the development of international relations. It is because of these changes that traditional standards of education are being subjected to criticism. It is because traditional concepts of culture and knowledge no longer appear to function in a changing world that new theories of education are being sought. Underlying all theories of education, irrespective of differences due to national prejudices, variant philosophies of life, and diverse psychologies, the emphasis is everywhere on the individual as an active agent in his education through participation in social experience. The old emphasis on the acquisition of knowledge is giving place to an emphasis on the acquisition of the tools and techniques of acquiring experiences, interpreting it, and using it as an instrument of control. In its extreme form the new tendency even insists that the experience and activities, the needs and interests of the learner are paramount and that nothing shall be prescribed in advance. (*See EXPERIMENTAL EDUCATION.*)

The general tendency, however, of the pragmatic position does not imply this type of freedom which denies virtually the place of organization and system in education. Starting with the concept of the unity and continuity of experience, it insists that knowledge can best be acquired through the active participation of the learner and becomes a part of his experience as he uses and verifies it. Experience has primarily a social basis. Even the individual who devotes himself to activities that involve his own appreciation and satisfaction engages in activities that have social meaning, e.g., music, art and literary pursuits, since they are the products of social environment, past, present and in the making. The resultant of this theory is the experimental habit of mind which involves and results from a sharing of interests and activities that have a social significance, but also control of these and readiness to change as the need arises.

The Traditional School Under Criticism. From the point of view of this theory the traditional school is open to a number of criticisms. The traditional school emphasized passivity, control, external discipline, and pouring in of knowledge, unselected and indiscriminate. It stressed acquisition or mastery of subject matter through repetition, drill and memorization. It assumed certain mystical and magical values which would somehow or other mold and shape the individual. The curriculum was a patchwork, made up of scattered pieces of information regarded, without proof, as valuable from the point of view of adult needs but disregarding the needs and interests and aptitudes of the pupils. The teacher instead of being a sympathetic guide was a harsh taskmaster whose chief duty was to assign and hear lessons to be learned from a textbook. The test of an education was not

ability or power or attitudes and ideals, but an examination of what had been stored in the memory. Growth was measured quantitatively rather than qualitatively. The general result of such an education, whose characteristics and defects are frequently exaggerated in the plea for the new, was an adult who found himself a misfit and who had to begin his education again on the real job of living.

Reconstruction of the Theory of Education.

The outcome of the emphasis on experience of which the individual is to be the center is a new theory of education in terms of the three factors or elements in the educative process: (1) the individual with his native endowment, needs and interests; (2) the aims, values, ideals and standards of society, and (3) experience mediating between the two. Education does not cease to be a preparation while it is life, since the growth of the individual is determined by his sharing and participation in social living and experience at every stage and by engaging in activities which grew out of the experience which he already has and which reaches out for the new. In the new school the pupil must no longer be a passive but an active agent. Hence the tendency to organize the content of the curriculum in terms of activities, experience or projects. The function of education is to guarantee the fullest all-round growth of which the individual by his native endowment and potentialities is capable through the provision of a favorable environment and opportunities for his development. The end of education is not the individual who has acquired a mass of information, much of which he will proceed to forget, but an integrated personality, socially active and contributing of his best to society, but promoting the development of social aims and purposes because he is critical and open-minded, recognizing his duties as well as his responsibilities. In this sense education can promote the great end of life, the realization of individuality.

The New School and New Methods. The school does not cease to be an institution deliberately created by society for the promotion of its own ends providing a selected environment for the attainment of cultural purposes. It will differ from the traditional school to the extent that it takes carefully into consideration the nature of the individual and of experience and the character of the learning process, which means that it must lay its emphasis not on subject matter to be learned, memorized and repeated, but on the individual as an active agent learning by experience. The general significance of this trend in a modern progressive, democratic society is that the school, even though an artificially created, purposive institution, is merely a part of the larger social environment, a macrocosm governed by the same laws of growth, experience and interrelationships as the great world outside. There will be no break in gauge between the school and the home, between the school and society.

With this definition of the school and of education there is widespread agreement. It has already had an invigorating effect on elementary education and on

the making of curricula in the United States; to only a slight extent have secondary and higher education been affected as yet. In England, which is less given to theorizing about education than the United States or Germany, some indirect influences of the theory may be detected. The whole of German theory and practice, particularly in elementary education, has been modified since the Revolution, and the reorganization is being carried forward in the interests of the new democratic form of government and the new place of the individual in society and the state. The activity methods and the activity program of the United States are paralleled by the demands for the *Arbeitsschule*, *Arbeitsunterricht* and *Arbeitsprinzip*. Governing all the movement is a desire to abandon the fixed, traditional concept of culture, and to substitute for it the concept of culture as something spontaneous and constantly in a state of reconstruction and progress. The *école active* and the centers of interest, emanating from Belgium and Switzerland, are exercising a profound influence in French and Spanish speaking countries. Even Russia and Italy, different though their political philosophies are from those of a democracy, have accepted the principles of activity as a basis of the educative process up to a certain point determined by political considerations.

Theory and Practice. Despite the apparent unanimity on the new theory of education, based on experience, activities, individuality, and progressive social purposes, it would be idle to look for the reform in all schools. Education after all is a social institution and is not wholly autonomous and determined by esoteric principles of a profession. The adult generation in any society tends to seek the perpetuation of the type of school through which it passed itself. There is also a certain professional inertia among teachers which must be taken into account. New developments in education must accordingly await the adequate preparation of teachers and the education of the public, which has in many countries resulted in the organization of PARENT-TEACHERS' ASSOCIATIONS, one of whose purposes is to explain the new aims and practices to those primarily interested in the education of their children.

But there is another reason for the gap between theory and practice which can be explained by the lack of unanimity about the practical application of the theory. There are those who, perhaps as a protest against the traditional school in which, it is charged, the pupil was merely a passive recipient, insist that the new school should not be dominated either by subject matter fixed in advance or by the teacher but should be child centered. There must be freedom for the child, not restraint or coercion, or imposition from without. The school must be active, not passive. Child interest must be employed as the orienting center of the school program. And the child must have the right of exercising his initiative in the selection of his activities, or they cease to be meaningful and significant for his experience. Others again stressing activities as the reformed method of curriculum

organization tend to lay greater emphasis on active manipulation and construction, on self-expression, on creation rather than on knowledge and seem to show just as much mystical faith in the virtue of activities alone as their predecessors did in the virtue of knowledge and information. In both cases the feeling whether explicit or implicit, is that whether the activities are initiated by the child or mildly and subtly suggested by the teacher, the child will automatically and spontaneously grow into a socialized individual. In both cases there is frequently striking similarity in the series of activities in which the child engages, so striking as to give the impression that they are becoming formal and stereotyped patterns. The implication of the child centered school is that the child must be active, and the teacher must subordinate herself or become passive. This tendency may be ascribed to a misinterpretation of experience as something first hand, direct and immediate. Again this represents a protest against the overemphasis on knowledge and verbal symbolism. Experience, however, is not subject to such a narrow definition. It is, of course direct and immediate; but such experience is but the starting point for new experience of others or from the printed page. It is significant that most educational experiments which have been conducted on the principles of the child centered school or of direct activities have dealt with young children and have compromised in time with some of the practices of the traditional school.

The Place of the Teacher. The corrective is to be found in defining the new place of the teacher in the educative process. Since the school is an institution to furnish opportunities for desirable experience from the point of view of the society which provides it, and education is the progressive growth from immature to mature experience, a mediator between the school and society and between the two types of experience continues to be essential. The teacher, it is true, should not be merely an assigner and hearer of lessons, nor can he be a mere bystander. From one aspect he should be an interpreter of society, selecting experience that will promote desirable growth. From another he should be an active participant and cooperate in planning the experience or situation called for at any moment in such a way that the pupils will enter into the partnership and engage actively as agents of the learning process. Such an interpretation of the theory of education implies a new type of preparation, more prolonged, and more professionalized. The teacher whose function was limited to carrying out the directions of others, a prescribed curriculum and course of study, by prescribed methods, could readily acquire the techniques of the process by an apprenticeship system. But the new teacher must not only understand the nature of his pupils, how they experience, how they learn, their interests and needs at different stages of their development, but must also acquire a rich background of culture and understanding of the meaning of civilization and progress for whose advancement society ap

points her as the agent. The teacher is not merely to be the bystander to watch the activities of the pupils, but the interpreter and planner of a continuous process which leads to consciously recognized, even though progressive and richer goals. Growth of the child on the basis of experience is meaningless unless it is governed by some goal, purpose or ideal.

Educational Leaders. The theory of education discussed in the previous pages, a theory with which will always be associated the names of JOHN DEWEY, not only in the United States but in many parts of the world; of Sir Percy Nunn in England; of Georg Kerschensteiner in Germany; of Adolphe Ferrière in Switzerland; and Olive Decroly in Belgium, despite certain differences between them, has the advantage not only of breaking down the dualisms referred to above but of laying the basis for an unbroken education from the earliest dawn of infancy (some would carry it even further back) to the end of life. Education is not merely life but continues throughout life. It is no accident that the richer and fuller recognition of the meaning of democracy, out of which this theory has in part emerged, is ceasing to be content with one type of education for the masses and another for the classes, but seeks to provide opportunities for the varied reconstruction of experience from earliest childhood by means of the nursery school and other types of pre-schools, a richer elementary school and differentiated forms of adolescent education, through adult life by means of diverse types of adult education. I. L. K.

BIBLIOGRAPHY.—The list of books on the theory of education is so vast that nothing more can be attempted here than to give a select list of books and refer the reader to the *Educational Yearbooks* of the International Institute of Teachers College, Columbia University, 1925 to date, which contain bibliographies of the most important works on education which have appeared since 1924; Part II of the volumes for 1924 and 1925 in particular are devoted to two aspects of educational theory, methods and curriculum. The following list is accordingly selective: Sir John Adams, *Evolution of Educational Theory*, 1912; T. Alexander and B. Parker, *The New Education in the German Republic*, 1929; B. H. Bode, *Modern Educational Theories*, 1927; J. Dewey, *Democracy and Education*, 1916; P. Monroe, *Textbook in the History of Education*, 1916.

EDUCATION, UNITED STATES OFFICE OF, a department established in 1867 by Congress. In 1869 it was incorporated in the Department of the Interior. The office studies educational developments in the United States, making national surveys, and specific surveys such as land grant college, secondary education and school finance surveys; distributes statistics thus obtained, and generally promotes education throughout the country. It can act only in an advisory capacity, having no jurisdiction over state school systems. The office supervises the allotment of funds for land grant colleges. The office has one of the largest and most complete educational libraries in the world. This library is open to anyone doing advanced research work on educational problems.

EDUCATIONAL DRAMATICS. It is generally believed that English drama began in educational in-

tent—in the desire of the churchmen of the Middle Ages to instruct the people in Biblical lore. Aside from priests and members of the court, few of the inhabitants of England were able to read and fewer still could understand the church services conducted in Latin; hence, the growth of little interpolations in the Mass ceremonies and the acting out of the Christmas and Easter stories in order that they might be known.

Gradually the purpose of education dulled and the desire for entertainment grew. T. H. Vail Motter, in *The School Drama in England*, suggests three periods of development in the school drama. 1. From the beginning to 1576—the period of independent growth. 2. From 1576 to 1642—the period of competition and defeat. 3. From 1642 to the present—the period of dependence and imitation. As the last-named stage would indicate, the idea of drama as entertainment has been uppermost for some centuries and the theater has had little to do with formal education.

But educators of to-day have come to realize that dramatics provide them with one of the most effective methods of instruction. Ever-increasing numbers of educational institutions have arisen in which the producing of drama is recognized as a legitimate part of the formal curriculum. This conception seems to have begun in the colleges and to have found its way more slowly into the high schools and elementary schools. College instructors have found educational dramatics to serve many purposes. Among them are furthering the student's knowledge of dramatic literature, both classic and modern, developing his powers of creative expression through the study of play-writing, increasing his appreciation of the arts, through instruction in stage design, acting, etc. College authorities have been quick to recognize these values, and dramatic work, frequently introduced as extra-curricular, has become in a great many institutions of higher learning the subject of courses leading to the A.B. degree. So far in America only a few colleges have admitted courses in dramatics as acceptable for a degree of Master of Arts, but the growth of schools of drama has shown a marked increase. (See THEATER SCHOOLS.) In some German universities one may even take a doctor's degree in the Theater Arts. In Germany the advanced degrees are taken almost invariably by students who intend to follow the theater professionally. In America the majority of those taking advanced courses in theater subjects are preparing themselves not for the stage but for teaching these subjects in other colleges and in secondary schools.

With the growing popularity of educational dramatics American universities have become very generous to their dramatic departments. Many state universities and the more affluent independent institutions have built completely equipped theaters for their students in order that their instruction might lack nothing in practical application. The use of educational dramatics in England has been so successful in the schools that Motter is led to the suggestion of a fourth period to be added to those listed above, a period in

which "the school drama will find the schools themselves as a part of the Little Theater movement supplementing the professional stage by the production of suitable plays not readily available in the regular theater. . . . In both America and England, where the educational utility of a play is a factor in its selection, the school drama justifies its existence as it could not otherwise do. . . . If the schools of to-day are to profit by the history of their own drama, they will present plays written for them, often by themselves, and other plays of such a nature as to be beyond the scope of the ordinary theater."

The Board of Education of London in 1926 showed how the idea of educational dramatics has reached not only the English schools but many agencies of adult education, which include The National Adult School Union, the Y.M.C.A., the Workers' Educational Association, churches, schools, prisons, clubs, offices and rural drama societies. All of these will be found to have their American counterparts.

The increase in the number of students electing theater courses in universities and colleges is a strong index of the increase of interest in educational dramatics among the high schools and private schools. Kenneth Macgowan, in his survey of the non-commercial art theaters of the United States, *Footlights Across America*, published in 1929, made the following estimate: "A third of the 22,000 high schools of America are probably studying and applying production methods to a rather decent grade of play. These 7,000 have definite courses with an average of 50 students to a course." These figures effectively explain why universities are now accepting students who offer entrance credits in dramatics and also why the number of college students preparing themselves to teach dramatics is growing so rapidly.

In schools below high school grade educational dramatics, while comparatively a new idea, have taken a surprisingly strong hold in the last few years. Even the nursery schools and the kindergartens find dramatics an effective mode of study. Instructors hope to instill into their very young pupils a true appreciation of music and design and the other arts of the theater. So important has the subject become that the city of Seattle has gone outside its public schools to add to dramatic work by erecting seven field-house theaters in its several parks. Each year more than 500 children appear in public performances of the annual "spring play." C. CA.

BIBLIOGRAPHY.—H. Granville Barker, *The Exemplary Theatre*, 1922; *Report of Adult Education Committee of the Board of Education, being Paper No. 6 of the Committee*, London, 1926; T. H. Vail Motter, *The School Drama in England*, 1929; Kenneth Macgowan, *Footlights Across America*, 1929.

EDUCATIONAL GUIDANCE. The rapid expansion of the courses and curricula in high schools and colleges, changes in home and school conditions, and the complexity of modern social and economic organization combined with the realization of the great variety of differences between individuals have given rise to the need of some form of guidance, direction or advice. Educational guidance is used some-

what flexibly for advice in a variety of situations in which the high school and college students find themselves, such as choice of courses, athletic and social activities, questions of conduct and personal relations. The term vocational guidance, also a form of educational guidance, is used more specifically of advice given on the selection of and preparation for a career. The establishment of exploratory courses in junior high schools and of orientation courses in colleges represents an attempt to guide students in the choice of courses. Educational guidance may be based on scholastic, health, social and physical records and on intelligence and aptitude tests. In a fully developed program for educational guidance the cooperation is needed of the school principal, teachers, psychologists, and the home and in more serious cases of the psychiatrist. In larger schools and colleges the position of personnel director, educational counselors, or dean of women has been created, where the function is not exercised by other administrative officials. Cooperation with parents and knowledge of home conditions are frequently necessary to cope with cases of maladjustment, which in the case of younger children are dealt with by visiting teachers and CHILD GUIDANCE CLINICS.

BIBLIOGRAPHY.—H. D. Bragdon, *Counseling the College Student*, 1929; J. M. Brewer, *Cases in the Administration of Guidance*, 1929; A. H. Jones, *Principles of Guidance*, 1930.

EDUCATIONAL SOCIOLOGY. See SOCIOLOGY, EDUCATIONAL.

EDWARD II (1284-1327), King of England, was born at Carnarvon, Wales, on Apr. 25, 1284. The fourth son of Edward I by Eleanor of Castile, in 1301 he was created the first Prince of Wales. He succeeded to the throne in 1307, and in the following year married Isabella of France. Edward was a weak king, and strongly influenced by court favorites, notably GAVESTON. In 1314 and again in 1323 he was defeated by ROBERT BRUCE, who was permitted to assume the royal title of Scotland. When his queen, Isabella, entered an intrigue with the dissatisfied barons in 1326, Edward was deposed by Parliament, made a prisoner and murdered in Berkeley Castle near Gloucester on Sept. 21, 1327.

BIBLIOGRAPHY.—G. M. Trevelyan, *History of England*, 1926.

EDWARD IV (1442-83), King of England, was born at Rouen, Apr. 28, 1442. Upon the death of his father, Richard, Duke of York, at the Battle of Wakefield in 1460, Edward became the leader of the Yorkist party. (See WARS OF THE ROSES.) Crowned as King in 1461, he was not secure in his position until after the Lancastrian defeats at Barnet and Tewkesbury in 1471. Due to his relation to the Nevilles on his mother's side, his reign was largely a quarrel between the Nevilles and the Woodvilles, the latter being the family into which he secretly married in 1464, thus alienating his maternal relatives. This breach was further widened by his favoritism for Burgundy against France. Despite his tyranny Edward managed to maintain con-

siderable popularity among his subjects. He was a patron of the arts, and gave encouragement to Caxton in the development of printing. He died at Westminster Apr. 9, 1483.

EDWARD V (1470-83), King of England, was born in Westminster Abbey, Nov. 2, 1470, the son of Edward IV and Elizabeth Woodville. Being only a boy when his father died, his uncle Richard, Duke of Gloucester, the Regent, afterwards Richard III, imprisoned him and his younger brother in the Tower of London, where in Aug. or Sept. 1483 they were murdered. The story of the princes in the Tower is one of the best known tales of English history. (*See ROSES, WARS OF THE.*)

EDWARD VI (1537-53), King of England, was born at Greenwich, Oct. 12, 1537. He was a son of HENRY VIII by his third wife, Jane Seymour, and there was much rejoicing in the royal household when a male heir was born. But Edward had a frail constitution and outlived his father by but a few years. The six years of the boy king's reign, 1547-53, were largely influenced by his maternal uncle, the Duke of Somerset, and the Duke of Northumberland. Edward was an ardent Protestant and it was during his reign that the Book of Common Prayer was adopted. He died at Greenwich July 6, 1553.

EDWARD VII (Albert Edward) (1841-1910), King of Great Britain and Ireland and of the British Dominions beyond the seas, and Emperor of India, was born at London on Nov. 9, 1841. He was the oldest son of Queen Victoria and Albert, Prince of Saxe-Coburg and Gotha. After attending Edinburgh University, Christ Church, Oxford and Trinity College, Cambridge, he gained wide experience through extensive travel, visiting Italy, Spain, the United States, Canada and the Holy Land. Later he made several trips to Russia, and went to Egypt in 1869 and to India in 1875.

After his marriage in 1863 to Alexandria, a Danish princess, Marlborough House became his official residence in London, Sandringham in Norfolk being purchased for their country estate. As Queen Victoria preferred retirement after the death of her husband, the prince and princess took a prominent part in public functions as well as in the social life of the nation. Both won great popularity through their tact and good judgment. Probably no other heir to the throne has been so assiduous in his devotion to public duties while at the same time showing a marked penchant for Paris life. With a love of pageantry Edward VII combined a fondness for sport, that appealed to the British people. Three times his horses won the Derby, while his racing yacht, *Britannia*, was one of the best of its time. He founded the Prince of Wales (afterwards King Edward's) Hospital Fund, was elected grandmaster of the Freemasons of England, was a bencher and treasurer of the Middle Temple and was the first chancellor of the University of Wales.

After his accession to the throne on Jan. 12, 1901, his influence on Government policies, particularly in

foreign affairs, greatly increased. At the same time, he cooperated with, rather than guided, his ministers. Because of this, he was much more closely associated with the epoch making changes in the international relations of Europe at the turn of the century than would have been possible for a monarch with less tact and political sagacity. These changes are sometimes spoken of as the Diplomatic Revolution, marking, as they do, the departure of England from her long standing policy of isolation to one of active participation in the alliances of the Continent, and the abandonment of a traditional friendship with Germany for a close understanding with her former rivals, France and Russia. How far the disagreements with his nephew William II influenced him in his anti-German attitude it is difficult to say. Certainly the former's self-assertion and stupid boasting did much to alienate the uncle, whose quiet self-possession and discreet support of his ministers' policies on his many visits to foreign sovereigns contributed not a little to the ultimate isolation of Germany.

At home Edward VII found himself carried along by the great social reform movement sponsored by the Liberal leaders in their repudiation of *laissez faire*. It was only by the exercise of unusual tact based upon his wide experience that the King avoided coming to an open rupture with the Government over Lloyd George's social legislation. But his health was failing, and on May 6, 1910 he died at London.

BIBLIOGRAPHY.—Wilkins, *Edward VII, the Peace Maker*, 2 vols., 1911; G. Farrar, *England under Edward VII*, 1925; Sir H. Lee, completed by S. F. Markham, *King Edward VII*, 2 vols., 1925 and 1927.

EDWARD, Prince of Wales (1330-76), called the "Black Prince," was born at Woodstock, June 15, 1330, the eldest son of Edward III and Philippa of Hainaut. His black armor led to his soubriquet. He married his cousin Joan, countess of Kent, in Oct. 1361. He was made Prince of Aquitaine in July, 1362, and given domains in southern France. Edward distinguished himself in the battle of Crécy in 1346, at Poitiers in 1356, at Nájera in 1367, and in the capture of Limoges in 1370. While in France, Edward contracted the disease which caused his death on July 8, 1376, at Westminster.

BIBLIOGRAPHY.—Chandos the herald, *Life of the Black Prince*, 1910.

EDWARD, PRINCE OF WALES (1894-), son of King George and Queen Mary of England, was born at Richmond Park, June 23, 1894. Trained for the navy at Osborne, Dartmouth, and as a midshipman on H.M.S. *Hindustan*, he later studied French in Paris and served terms at Magdalen College, Oxford. In 1911 his investiture as Prince of Wales was celebrated at Carnarvon Castle in Wales. The Prince served with the British forces in France during the war. After the Armistice he traveled widely throughout the world, visiting the United States and South America in 1919 and in 1931. He achieved a remarkable personal popularity and while

taking no part in administration, he studied politics closely and acquired facility as a public speaker. He has advocated a reorganization of British industry and salesmanship in foreign countries, especially in South America. His income, about \$250,000 a year, is derived from the revenues of the ancient Duchy of Cornwall.

EDWARD, LAKE, or **ALBERT EDWARD NYANZA**, in central Africa, south of the Equator. It is situated in the Great Rift Valley on the border between the British Protectorate of Uganda and the Belgian Congo. The steep edge of the Archean plateau bounds it on the east and west; the volcanic cone of Mount Ruwenzori overlooks it on the north; and the plain of Ruchuru spreads to the south. The lake is about 40 mi. in both length and breadth, lies over 3,000 ft. above sea level, and covers an area of about 1,500 sq. mi. The basin provides one of the sources of the Nile, expelling its waters into Lake Albert through the Semliki River. It was discovered in 1876 by the explorer, HENRY M. STANLEY.

EDWARDS, JONATHAN (1703-58), American divine, philosopher and theologian, was born at East Windsor, Conn., on Oct. 5, 1703. He graduated from Yale in 1720, spending two years thereafter in the study of theology. After a year of service as minister to a Presbyterian congregation in New York, in 1724 he became a tutor at Yale. He went to Northampton, Mass., in 1726 to share with his grandfather, Solomon Stoddard, in the Congregational parish. The next year he married Sarah Pierrepont, great-granddaughter of THOMAS HOOKER, and daughter of James Pierrepont, a founder of Yale. In 1729 Stoddard died, and Edwards took full charge of the Northampton parish. Having disapproved of Arminianism from earlier years, Edwards first attacked it in a sermon in 1731, holding that salvation was purely a matter of God's saving grace. Two years later he began a revival which converted hundreds to his doctrine and the spirit of which spread through the Connecticut valley. It was succeeded in 1739-40 by the Great Awakening, a movement led by Edwards. Disputes arose which, linked with an attempt by Edwards to investigate the moral conduct of certain members of his parish finally led to his dismissal in 1748. He then went to Stockbridge in 1750 to preach to the Housatonic Indians. In 1758 he became president of the College of New Jersey, but died on Mar. 28, 1758, one month after his installation.

His published works include *Freedom of the Will*, 1754; *The Nature of True Virtue; Original Sin; Humble Relation*, 1752; *Thoughts on the Revival in New England*, 1742; *A Faithful Narrative*, 1737; and *God Glorified in Man's Dependence*.

EDWARDSVILLE, a city in southwestern Illinois, the county seat of Madison Co., near Cahokia Creek, 18 mi. northeast of St. Louis, Mo. It is served by five railroads. There are coal fields in the vicinity, and good farming country. Edwardsville has various industries. Near by is Leclaire, a company-owned village, projected by the Nelson Manufacturing Co.,

manufacturers of plumbers' supplies. Prehistoric mounds are in the neighborhood. Pop. 1920, 5,336; 1930, 6,235.

EDWARDSVILLE, borough in Luzerne Co., northeastern Pennsylvania, situated in an anthracite coal-mining region on the Susquehanna River. Kingston Station, Wilkes-Barre, which is just across the river, is the post office. Pop. 1920, 9,027; 1930, 8,847.

EDWARD THE CONFESSOR (c. 1004-66), King of England, was born about 1004 at Islip, Oxfordshire. He was the son of AETHELRED II, the "Unready," and Emma of Normandy. During the period of Danish supremacy in England Edward lived in Normandy. He succeeded HARDICANUTE as king of England in 1043, largely through the influence of Godwin, Earl of Wessex, and in 1045 married Edgitha, Godwin's daughter. The *Laws of Edward the Confessor* were compiled during his reign. Edward died Jan. 5, 1066. He was canonized in 1161.

EDWARD THE MARTYR (c. 963-978), King of the English, was the son of Edgar, and ascended the throne at the death of his father in 975. After a brief reign of three years characterized by internal ecclesiastical disputes, he was assassinated in 978 in Corfe, Dorsetshire, and was succeeded by his half-brother, Aethelred the Unready.

EEKSEN, an American Indian tribe living at Oyster Bay on the east coast of Vancouver Island, in Brit. Col., speaking the Comox dialect of the Salish linguistic stock.

EEL, the common name for a group (*Apodes*) of elongated snakelike fishes. They lack tail and ventral fins, but have a single soft spineless fin running over the back, the posterior end of the body and forward on the belly. The smooth slimy skin is covered with very small rudimentary scales or none.

The common eel (*Anguilla rostrata*) is abundant in fresh and brakish waters along the Atlantic coast from Newfoundland to Central America. It usually grows 18 to 30 in. long, although sometimes attaining a length of 5 ft., and is olive brown above becoming paler below. In habit it is catadromous, living in fresh water but going to salt water to spawn. Omnivorous, voracious and exceedingly active, this eel does not hesitate to attack any living creature. Though feeding largely upon fresh-water fishes it also devours much dead animal matter, performing valuable service as a scavenger. It seeks its food chiefly at night, often lying buried in the mud by day. Eels are exceedingly prolific, a female usually laying 5 to 10 million eggs, and after spawning die. The transparent, ribbon-shaped larvae develop in salt water; in the second year the young eels ascend the rivers in immense numbers.

The eel is an excellent food fish with tender, oily, agreeably flavored flesh. In the United States the annual catch usually exceeds 2,000,000 lbs. Closely allied species in Europe and Japan are also esteemed as food fishes.

EELGRASS (*Vallisneria spiralis*), a submerged aquatic perennial of the frog's-bit family called also

tape grass and wild celery. It grows in shallow fresh waters very widely throughout the world; in North America it occurs from Nova Scotia to Minnesota southward to Florida and Texas. The very short stem, which roots in the sand or mud, bears a tuft of narrow, green grasslike leaves, usually 1 to 6 ft. long. Eelgrass is remarkable for the curious manner in which the process of fertilization is effected. The male (staminate) and the female (pistillate) flowers are borne on separate plants. The extremely minute male flowers are seated in large numbers on a short stalk near the base of the leaves. At maturity the tiny flowers become detached and rise to the surface where the pollen is discharged. Each female flower, inclosed in a tubular spathe, is produced singly at the end of a long, slender, spirally-twisted stalk. This threadlike stalk uncoils more or less according to the depth of the water, allowing the expanded flower to float upon the surface where it is fertilized by the pollen from the exceedingly numerous male flowers drifting about it. As soon as pollination has taken place the spiral stalk coils up again, conveying the flower to the bottom where the fruit, an elongated, many-seeded berry, ripens.

Eelgrass, by sportsmen commonly called wild celery or water celery, is a favorite food of the canvas-back duck and the redhead, highly prized by epicures.

EEL-WORM, the common name for members of a family (*Anguillulidae*) of threadworms. The most familiar of them is the vinegar eel which is often found wriggling about in vinegar which has not been kept in an airtight container. It feeds on the vinegar and hinders acetification, but it is harmless to man. Other eel-worms live in the ground, feeding on decaying organic matter, and still others feed on living plants. Among the latter are the serious pests that cause common clover disease, beet sickness, which has been most troublesome in Germany, and serch, a disease of sugar cane in the East Indies. Eel-worms are also responsible for injurious galls on orange and peach trees, and on cotton plants. See also VINEGAR EEL.

EFFLORESCENCE, the passing of water of crystallization from a hydrate into the atmosphere at ordinary room temperature. Some hydrates, as washing soda, are so unstable that the vapor pressure of water within them is greater than that of the atmosphere, with the result that they lose their moisture and become a pulverulent mass.

EFFLUVIA, a substance alleged to flow from the body and related to its spirit essence. The term belongs to occult study. It may have been suggested by the act of sneezing, with which superstitious customs are connected.

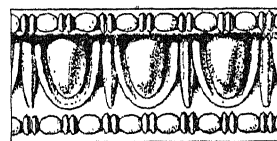
EGAN, MAURICE FRANCIS (1852-1924), American educator, author and diplomat, was born in Philadelphia, Pa., May 24, 1852. He studied at La Salle College, and became in 1888 professor of English literature at the University of Notre Dame. In 1895 he accepted the same office at the Catholic Uni-

versity of America, and later lectured at Johns Hopkins and at Harvard. President Roosevelt appointed Egan in 1907 United States minister to Denmark, where he served until 1918. His books include several novels, *Studies in Literature*, 1899; *Ten Years Near the German Frontier*, 1919, and *Recollections of a Happy Life*, 1924. He died at Brooklyn, N.Y., Jan. 15, 1924.

EGBERT or **ECGBERHT** (?-839), King of Wessex or of the West Saxons, ascended the throne in 802. Having taken refuge at the court of Charles the Great in his youth, he learned something of the science of government of motley peoples. Therefore, when he returned to England, he began his conquests of Britain. In 828-29 Egbert forced all of southern England to submit to his overlordship, and may therefore be thought of as the first king of England. He reigned for 37 years, during which he carried on vigorous war against the Danes, and was succeeded by his son Ethelwulf. Egbert died in 839.

EGER. See CHEB.

EGG AND DART, in classic architecture, a common ornament used for decorating the ovolo, or convex quarter-round or quarter-elliptical molding. It consists of convex egg-shapes, framed with a projecting border, separated from each other by thin projecting elements often resembling arrowheads. The rhythmical light and shade pattern, produced by the convex form of the egg contrasting with the deep narrow shadows around the frame and on either side of the dart, is marked and effective. The egg and dart is a carved derivative of a Greek painted molding ornament which was based on the Egyptian lotus bud and lotus flower band. (See Lorus.) The Greek egg and dart is usually long, slim and deeply cut, with fine arrises or edges on the frames; the Roman and Renaissance examples are wider, flatter and generally coarser. The Romans occasionally used much ornamented forms, in which the egg was carved as if wrapped in delicate acanthus foliage.



EGG AND DART MOLDING
From the Erechtheum, Athens

EGGFRUIT (*Lucuma nervosa*), a small tree of the sapodilla family yielding a sweet flavored edible fruit, called also canistel. It is a native of tropical America cultivated in various warm regions and naturalized in southern Florida. The tree grows 10 to 25 ft. high with spreading branches bearing large, smooth, oblong leaves, whitish flowers and a globular, orange-yellow, berry-like fruit, 2 to 4 in long. In Great Britain the EGGPLANT is known as eggfruit.

EGGLESTON, EDWARD (1837-1902), American writer, was born at Vevay, Ind., Dec. 10, 1837. At first a Methodist circuit rider, he edited successively the *Chicago Sunday School Teacher*, *The New York Independent* and *Hearth and Home*. His *Hoosier School-Master* appeared in 1871, bringing him fame. After preaching in Brooklyn from 1874-79, he

retired to Lake George and devoted himself to writing. Among Eggleston's books are *The Circuit Rider*, *The Graysons* and a *History of the United States*. He died at Lake George, N.Y., Sept. 3, 1902.

EGGPLANT (*Solanum Melongena*), an annual plant of the nightshade family, called also aubergine and guinea-squash, widely grown in warm regions as a vegetable. It is believed to be a native of India, where its cultivation, now extensive, dates from remote antiquity. The plant is usually about 2 ft. high, with a somewhat woody stem bearing large prickly leaves and usually solitary violet flowers, about 2 in. across. The somewhat globular or oval fleshy fruit, sometimes 6 or 8 in. in diameter and 12 in. long, is used as a vegetable, being usually sliced, dipped in batter and fried. Eggplant is readily grown in many parts of the United States, and its commercial cultivation for city markets is of importance in several states, especially New Jersey, Florida and Louisiana.

EGGS. An average size hen's egg weighs about 2 oz. and consists of about 11% shell, 57% white and 32% yolk. Average figures for composition and nutritional energy value (1) of the entire edible portion of the egg, (2) of the white, and (3) of the yolk, respectively, are:

	Water	Protein	Fat	Mineral matter	Calories per lb.
(1)	73.7	13.4	10.5	1.0	670
(2)	86.2	12.3	0.2	0.6	230
(3)	49.5	15.7	33.3	1.1	1645

The yolk is more concentrated in nutrients than the white, its chief protein being ovovitellin. Ovovitellin contains phosphorus and sulphur in addition to the elements carbon, hydrogen, oxygen and nitrogen. In its percentage of these elements it is quite similar to CASEIN. A large proportion of the yolk fat consists of phosphorized fats called lecithins. In calcium, phosphorus and iron the yolk is richer than the white while the latter is richer in sulphur. The color of egg yolk varies from pale yellow to almost red due to varying quantities of organic pigment, the amount of the latter depending upon the diet of the hen, green leaves producing deeper colored yolks. The larger proportion of the vitamins (*see VITAMINS IN FOODS*) in which eggs are rich is in the yolk.

The protein of egg white consists mainly of albumen with small amounts of conalbumen, ovomucin and ovomucoid. Some people claim that there is a difference between the flavor and richness of white shelled and brown shelled eggs but this opinion is not based on scientific measurements, and in fact the preference for shell colors varies in different markets.

Preservation of Eggs. Commercially, eggs are preserved by cold storage in the shell, freezing storage of egg-meats and by desiccation to powder.

Practically all eggs that are stored go into storage during the spring months, March, April, May and June. The removal from storage begins in the summer, increasing gradually until the middle of November and by the first of January the storage supply is practically exhausted. Only the best eggs are stored

and prior to storage they are carefully examined before the "candle" in order to eliminate all which show questionable quality.

Eggs in the shell are stored at 28-31° Fahr., 29° being considered the best and at carefully controlled humidity, 80-85% relative humidity being most highly favored. Lower temperatures are not feasible due to danger of freezing the egg. If an egg is frozen its shell cracks due to expansion of contents and the yolk becomes hard. The containers and storage rooms must be very clean and free from odors since the latter are readily absorbed by the eggs.

In storage there is some evaporation of moisture through the shell and a slight migration of water from the white to the yolk. Thus the egg loses in weight, becoming more concentrated in nutrients. At the same time the thick structural protein (*see PROTEIN IN FOOD*) constituent of the white loses its rigidity so that a storage egg after a certain length of time develops a thin white. This does not impair its quality since such white is more concentrated in solids and actually whips better.

For freezing storage of egg-meats, the eggs are just as carefully selected. They are broken out of the shell in a most sanitary manner, each egg being inspected for odor and appearance, all questionable ones being discarded. The perfect eggs thus broken out are churned in order to disrupt the yolks thus forming an egg batter which is frozen and stored at 0° Fahr., in cans containing 30 lbs. of batter. Such eggs are never stored more than one year, the withdrawals being as stated above. Chemically they suffer no change in quality and by means of this low temperature preservation the baker is able to obtain fresh spring eggs in the following fall and winter. Yolks containing added salt or sugar are similarly frozen to be used later in mayonnaise manufacture. Egg whites are also stored at 0° Fahr.

Dried eggs are usually prepared by spraying the egg batter in a room heated to a temperature of 160-170° Fahr. The spray loses about 90% of its water, the powder descending to the floor from which it is collected and packed in containers. While this powder keeps for a considerable length of time at ordinary temperatures, it is usually kept in coolers. Most of it is imported from China. A. W. T.

Eggs as Food. While eggs of various kinds are eaten, hens' eggs are much more commonly used than any other. A hen's egg, without its shell, contains 72-75% water, 12-14% protein, 10-12% fat and no carbohydrate. The color of the shell has no effect on the composition of the egg. Egg white (albumen) consists of water, protein, a little sodium, chlorine and potassium. The yolk is richer in protein, and contains fat, phosphorus, calcium, iron and vitamins A, B, D and G. While supplying less vitamin D than cod liver oil, it has been shown that the use of one egg yolk daily will prevent RICKETS. Egg yolk has also been found effective in forming red blood corpuscles. The energy value of the average white is about 14 calories, of the yolk 56 to 60 calories.

Both raw and cooked eggs are quite thoroughly and easily digested. The method of cooking has little influence on the completeness of digestion, although it may slightly affect the time required for the eggs to leave the stomach. Eggs are graded commercially according to freshness, cleanness, size, cracks and color. Freshness refers to the state of preservation of the egg and not merely to its age.

Cold storage, freezing and drying are methods of preserving eggs. The flavor and attractiveness of these products are generally considered inferior to those of strictly fresh eggs, but, if the processes are properly carried out, the nutritive value and wholesomeness of eggs so treated are not impaired.

H. T. B.

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EGLANTINE, a name given to a stout, erect, very prickly and bristly species of Rose (*Rosa Eglanteria*), native to Europe and widely naturalized in North America, called also sweetbrier. The eglantine mentioned by Gerard and other early herbalists was a shrub bearing white flowers; the "twisted eglantine" of Milton's *L'Allegro* may have been the woodbine (*Lonicera Periclymenum*), a twining species of honeysuckle. See SWEETBRIER.

EGOISM, an ethical teaching holding that the good of conduct is the interest of self, the opposite of altruism. Egoism has therefore been identified with selfishness. It is only a metaphysical interpretation of the self which could so regard it, however. In the light of modern psychology we have as many selves as we have interests, and for all intents and purposes, the self at any given time is identified with the interest operating. Thus there is the business self, the social self, the family self and the intellectual self, all of which make different demands at different times and lead to various manifestations of selfhood. From this standpoint the ego and the alter are inextricably merged and egoism as such ceases to have any definite meaning.

EGRET, the name given to various species of heron, usually with beautiful pure white plumage. At the breeding season they develop long soft plumage on the lower back. These handsome dorsal feathers have long been esteemed for ornaments by Oriental peoples and until recent years were much used in America for millinery decoration under the name of aigrettes. The American species, which were formerly very abundant in Florida but practically exterminated for the sake of their feathers, include the American egret (*Casmerodias albus egretta*), the snowy egret (*Egretta thula*), and the reddish egret (*Dichromanassa rufescens*), a remarkable bird showing two distinct phases of coloration, one pure white and one with chestnut and slaty gray plumage. With the forbidding of the use of aigrettes on millinery in the United States, egrets have increased and are again common in the Gulf states, occasionally

wandering northward after the nesting season as far as New England.

EGYPT, a kingdom situated on the northeast of Africa, extending from the Mediterranean Sea southward to 22° N. lat. and from 25° E. long. eastward to the Gulf of Suez and the Red Sea. The total area is approximately 385,000 sq. mi., and is divided into three principal sections: Egypt Proper, the Sinai Peninsula and certain islands in the Gulf of Suez and the Red Sea. Egypt Proper in turn is divided into the Nile Valley and delta, the Libyan or Western Desert and the Arabian or Eastern Desert. The Nile delta region frequently is referred to as Lower Egypt; the valley of the Nile above the delta and the Fayum district are called Upper Egypt. Most of the entire area of Egypt is desert; only about 412,500 sq. mi. is cultivable. Practically all of this arable land is located in the Nile Valley and delta.

Surface Features. The Nile River is the principal geographical feature of Egypt. Rising in equatorial Africa, the Nile enters Egyptian territory at the south and flows northward for 935 miles through this territory to empty into the Mediterranean Sea. The Nile has no tributaries in Egypt, and the evaporation from it in Egyptian territory considerably exceeds the rainfall. The river, fed from equatorial Africa, rises in July, reaches its greatest height in the middle of September, falls during the winter and is at its lowest in May. During the low-water periods, the water is clear; during high water, it is filled with silt and is turbid. The annual flooding of the nearby shores with the flood waters brings to them deposits of this rich silt which serve to maintain the fertility of the land.

Some little distance below Assuan, the Nile enters a trough in the Libyan limestone, which has cliff-like walls. The trough is filled with Nile silt, and forms the cultivated Nile valley strip known as Upper Egypt. Below Cairo, the bed widens out into the irregular-shaped Nile delta, which is known as Lower Egypt. The depression known as the Fayum oasis forms an important part of cultivable Egypt, and is watered from a canal connecting with the Nile.

The Libyan desert, stretching westward from the Nile to Tripoli, is a monotonously level limestone plateau. Most of it is utterly arid and inhospitable desert, but there are a number of depressions where springs and wells supply water for oases. Motor roads and light railways now connect these western oases with the Nile region. The Arabian desert, lying to the east of the Nile, has a backbone of mountains, rising to from 1,000 to 1,250 ft. above sea level, which stretches northwestward from Abyssinia to near the Suez Gulf and reappears in the Sinai Peninsula. These mountains lie quite close to the Red Sea, and their eastern slopes are much steeper than their western. The desert surfaces, both east and west of the Nile, consist partly of hard gravel and partly of sand. The prevailing north winds, in the Libyan desert particularly, blow the sand into dunes, sometimes 100 miles or more long and several miles across. The

arge and small dunes make travel by motor car from east to west extremely difficult.

Population. The population of Egypt has grown rapidly in the past century. Estimates at the time of Napoleon's venture into the country in 1798-99, gave a figure of 2,460,000. An estimate at the time of British entry in 1882 put the total at 6,831,131. The first official census in 1897 gave a figure of 9,734,405; the 1917 census gave 12,750,918, and that of 1927 reported 14,168,756 residents of Egypt. This included 153,947 foreigners, of whom 56,731 were Greeks, 40,168 were Italians, 24,354 were Britons and 21,270 were French. Sixty per cent or more of the population were "fellaheens," a group of Hamitic origin which is made up mostly of semi-serf laborers. The desert areas are inhabited by about 100,000 nomadic Bedouin Arabs. Over 99% of the people live in the Nile valley and delta, Fayum province and the Suez canal zone. The population density in the valley and delta is over 1,700 per square mile. Approximately 13,000,000, or 92% of the people are Mohammedans, and 850,000 or 6%, are Copts. The rest belong to various minor sects.

Flora and Fauna. The principal plants of Egypt are the various food grains and cotton, with palms of several kinds as the most important trees. Along the banks of the streams grow rushes which in ancient times were used in making papyrus and still are much used for baskets, mats and similar articles. The hippopotamus and crocodile have become almost extinct; gazelles and occasionally lions are found in the desert; wild boars sometimes are seen in the delta region; foxes, hyenas and jackals abound; birds of prey include eagles, vultures and hawks; venomous snakes, spiders and scorpions are common; a number of varieties of birds, some with brilliant plumage, frequent the shores of the Nile; fish abound in the river waters.

Climate. The atmosphere is clear and dry, and the temperature is high. Egypt is in the dry belt, and a feature of its climate is the hot and dry simoon, which blows from across the deserts from the south or southeast, chiefly in the spring and early summer. Winter, the most enjoyable part of the year, extends from November to March; summer from June to September; between are two short intermediate seasons. Annual mean temperatures are: Cairo, 67.1° F.; Alexandria, 67.4°; Khartoum, 82.7°. The highest recorded temperature has been at Assuan, 123.8°, the lowest at Giza, 24.8°. Annual rainfall averages have been: Cairo, 1.1 in.; Alexandria, 7.5 in.; Khartoum, 5.2 in.

Irrigation. From time immemorial, the flood waters of the Nile have been used to irrigate and, through the silt deposits, fertilize the bordering areas. This irrigation and fertilization alone have made possible the continuing cultivation of the land, except in the relatively small desert oasis where water is secured from wells and springs. The old system was to flood the land when the Nile rose in early autumn and to leave the water on the land for a couple of

months by which time the river had fallen and it could be drained off. The seeds then were planted, and the crops ripened in the spring. The crop depended largely on the area that could be flooded, which in turn depended on the height to which the river rose. In low water years, the crops necessarily were small; sometimes there were none.

In the past half century, much has been done in the way of building dams and other structures to conserve the water and to insure adequate supplies when the river flow was comparatively small. By these means it has been possible not only to insure much more reliable water supplies but, perhaps more important, to get water on the land more than once a year. In the areas which receive this "perennial" irrigation, approximately 4,150,000 acres, two and frequently three crops can be produced annually, instead of only one. Thus about 83% of the arable land is irrigated at least once a year, and 62% gets water regularly to produce more than one crop a year. This is why the comparatively small area can support so large a population per square mile. The Assuan dam at the upper end of the Nile valley impounds 3,520,000,000 cu. yds. of water. This is stored during the autumn and early winter when the water is clear, and released in the spring. The dam is emptied by the time the river begins to rise again in the summer. Barrages built in the river at a number of points both above and below Cairo serve to raise the level of the water and facilitate irrigation.

Agriculture. The occupation of the great majority of the people is agriculture, most of the actual tillers of the soil being the fellaheens, who live in small communities up and down the course of the Nile. Cotton has come to be the most important crop. Wheat, which was known in Egypt before historical times, maize, barley and beans are the principal food crops. Miller, sugar cane, rice, flax, onions, lentils and fruits of various kinds are also grown. Dates are produced in large quantities along the Nile and in the oases. The government has devoted considerable attention to the introduction of scientific farming, with measurable results. Oxen, buffalo, sheep, goats, donkeys and camels are the chief domestic animals. Chickens are raised in large numbers, and the export of eggs and egg products has become an important item in trade.

In the main, the agricultural implements and methods still are much the same as they have been for many centuries, and the life of the people revolves around the rise and fall of the Nile as it has since time immemorial.

Cotton. Cotton not only is the principal agricultural crop, occupying between 25 and 30% of the cultivated area, but it also is the largest item in the export trade of Egypt. Modern production was started in 1822; the crop for the 1877-78 season was 85,000 short tons, that for 1890-91 was 205,000 tons, that for 1920-21 was 301,250,000 tons, and that for 1929-30, which was the largest on record, 419,850,000 tons. Cotton exports in 1921 were \$142,000,000. In 1924

they reached a peak of \$283,500,000, after which, due chiefly to falling world prices of cotton, they dropped. In 1929 they were \$226,000,000 and in 1930 \$190,000,000. Cotton exports form around 80% of the total exports. The fall in cotton prices so seriously affected the economic life of Egypt that the government in 1926 and again in 1929-30 bought cotton in the hope of maintaining prices in Egypt. The attempts proved unsuccessful. Efforts to limit the area devoted to cotton production were only partially successful. In 1931 the price of Egyptian cotton fell almost to the lowest figure in modern history.

Minerals. Some gold is found in the hills of the Arabian Desert, but attempts to work the deposits commercially have not been particularly successful. Petroleum is being produced in moderate quantities along the Red Sea; production in 1930 was 1,900,000 bbls. No workable coal seams are known. One hundred and thirty-five thousand short tons of manganese ore were produced in 1930, and 345,000 tons of phosphate rock. Soda is produced at lakes 60 mi. north-west of Cairo.

Communications. The Nile is the principal channel of communications, providing a waterway for the small Egyptian sailing ships and shallow-draft steamers through most of Egypt. Camels furnish transportation in the desert areas, supplemented by light railways and motor cars to the principal western oases. The state owns the principal railways, of which some 1,650 mi. of main lines are open to the public. The total mileage of the state railways, including the lines to the oases is 2,270. In addition there are approximately 900 mi. of privately-owned light railways, mainly in the delta. Postal and telegraph communications reach throughout the Nile valley and delta, and connect with other parts of Egypt. Cable communications have been established with the outside world.

Principal Cities. CAIRO, the capital and the largest city, is situated at the head of the delta on the border between Upper and Lower Egypt. It had a population in 1927 of 1,059,824. In this city is located the Mohammedan university of Al Azhar, which has been the center of much of the nationalist agitation in recent years. Cairo was built as a new city and capital of the country by Janhar following his conquest of Egypt in 969. The next largest city, ALEXANDRIA, is Egypt's principal port and is situated on the Mediterranean at the mouth of the delta. It has a population of 570,314, according to the 1927 census. Port Said and Suez are at the ends of the Suez canal and are connected with the Egyptian railroad system through junction at the city of Ismailia. The modern town of Luxor, 12 hours by rail from Cairo, is situated on the site of "hundred-gated Thebes" which at one time was the capital of Egypt. An airport has been established at Heliopolis, near Cairo.

Industries. Mehemet Ali, soon after he secured control of Egypt in 1805, started a program of industrial development. The industries were operated as private monopolies of the khedive, however, and were

not notably successful and Egypt remains to-day little of an industrial country. Although large quantities of excellent cotton are produced in the country, the cotton piece goods imports are heavy, for example. Some weaving of cotton goods is carried on in Cairo and Alexandria; and cigarettes are made from imported tobaccos. The "industry" of catering to tourists is coming to be perhaps the most important in the country.

Education. About 90% of the population of Egypt still is illiterate, although the government in recent years has been giving attention to the development of primary education. The principal university in the country is that of Al Azhar, located at Cairo, which is a strictly Mohammedan institution. Various technical schools and other universities of lesser importance have been started. There are many mosque schools. The custom has been for the sons of those who could afford it to get their preliminary education from private tutors and then to go abroad, chiefly to France or England, for further training. Attempts to provide higher education date back to the time of Mehemet Ali, under whose régime a medical school was founded in 1827. Engineering, law, agricultural and normal colleges were started before the end of the century. Children to the number of 670,000 were in school in 1927.

Defence. Because of the geographical position of Egypt, and particularly of the Suez Canal, in relation to the parts of the British Empire, Britain has been specially interested in seeing to it that Egypt should not become dominated by any country likely to be an enemy of Britain. It has maintained virtual military control of the country since the middle of the 19th century, at which time Egypt nominally was part of the Ottoman Empire. Perhaps the most serious point of dispute between Britain and Egypt in recent years has been this of defence. The strictly Egyptian army consists of 11,700 men. The British troops are stationed in Egypt itself, in the Suez Canal zone and in the Sudan.

Finances. Ismail, who became head of the Egyptian government in 1863 and ruled until 1879, spent money so extravagantly that he made the country bankrupt and defaulted on international debts due to Britain and France. As a result, beginning in 1876, a system of dual control was introduced, with the British regulating the collection of governmental revenues and the French controlling expenditures. Developments in subsequent years resulted in the withdrawal of French participation and the passing to the British of control of Egyptian finances. This question of financial independence for Egypt is one of the serious points of dispute between the British and Egyptian governments. The reason advanced for continuing foreign control is that put forward at the time of the assumption of foreign domination: that without such outside control Egypt's foreign debts would not be paid.

During the fiscal year ending Apr. 30, 1930, actual revenues were \$209,430,000, and expenditures \$205,-

540,000. The next year the estimated budget balanced at \$224,575,000. For the year 1931-32, revenues were estimated at \$196,580,000 and expenditures at \$194,120,000. On Apr. 30, 1930, there was in the treasury a surplus of \$202,995,000, of which \$65,000,000 represented government investments in cotton and \$20,000,000 loans to cotton cultivators. During the 1921-30 period, the revenues had exceeded the expenditures by a total of \$182,980,000. The national debt stood at \$449,394,000 on Apr. 30, 1930. The principal revenue sources are the customs duties, particularly those on tobacco imports, the land tax and the railways and other communications. The chief expenses are for communications, "interior department" undertakings such as the central administration, police, public health, prisons, etc., and public works. Military expenses form approximately 6% of the total. \$12,500,000 was spent on education in 1927; a great increase from \$2,500,000 in 1917.

The chief unit of Egyptian currency is the Egyptian pound, which is subdivided into 100 piastres and 1,000 mills. In exchange at gold par rates, one Egyptian pound is worth in British sterling currency one pound and six pence or U.S. \$4.94. The British pound is used widely in Egypt, especially in foreign trade dealings, at a value of 975 mills.

Trade. Egypt's foreign trade showed a growth from a total of \$281,000,000 in 1911 to a peak of \$587,120,000 in 1925. The 1930 trade was \$397,155,000. Generally, there has been a surplus of exports over imports in recent years, though sometimes the balance has been the other way. For the period 1919 to 1930 the net export surplus balance was \$156,000,000. Agricultural products make up almost all the exports. Principal imports are cotton textiles and yarns, cereals and flour, machinery and hardware, and tobacco. In 1913 British trade with Egypt formed 30.5% of the total; in 1930 only 20.3%. 81.8% of Egypt's cotton imports in 1913 came from Great Britain; in 1930 the British supplied only 42.5%. Cotton textiles form approximately 10% of the total imports; cotton and cotton seed together about 87.5% of the exports. The trade with the United States was \$48,439,000 in 1925 and \$22,494,000 in 1930. Exports from Egypt to the United States were 15.3% of this trade in 1925 and 39.6% in 1930. Trade with France ranks second to that with Britain; that with the United States comes third.

Government. For most of the time from the conquest of Egypt by the Roman Empire in 30 B.C., down until 1922 Egypt remained subject to one or another of the neighboring countries, though there were periods in which Egyptian rulers dominated rather than were dominated by outsiders. For many centuries Egypt nominally was under the suzerainty of the Turkish Empire. This suzerainty continued in form but not in practice until Nov. 1914, when the British assumed a protectorate over Egypt as a war measure, Turkey having sided with the Germans in the World War. The British protectorate was formally ended in 1922 by a British declaration. Britain,

however, has retained a measure of directive influence in the matter of foreign relations and defence of Egypt.

The Egyptian government is a constitutional monarchy headed by a king. Organic laws were promulgated in 1883 and 1913. The first constitution was put into force by royal rescript on Apr. 19, 1923. After a period of disorganization and political upsets, a new constitution was promulgated Oct. 23, 1930. This declares that Egypt is a free, independent and sovereign state and that the throne is hereditary in the family of Mohammed Ali. It provides for a senate of 100 members of whom 60 are appointed by the king, and a chamber of deputies of 150 members, elected by indirect vote. The king may dissolve parliament and suspend sessions. The official state religion is Mohammedanism. The 1930 constitution, as compared with that of 1923, reduced the number of senators from 121 to 100, increased the number of senators to be appointed by the king from two-fifths to six-tenths of the total, reduced the number of deputies from 230 to 150, and greatly increased the power of the king over parliament.

Egypt is divided into six governorates, 14 provinces and four frontier provinces and districts. The governorates are Cairo, Alexandria, Port Said, Damietta, Ismailia and Suez. The 14 provinces lie in the Nile valley and delta areas. The frontier provinces and districts take in the desert regions on both sides of the Nile and the Sinai Peninsula region. The population of these frontier divisions and provinces is only about 100,000, or seven-tenths of 1% of the total, though their area is approximately 95% of the total. Local village affairs are in the hands of village councils, whose chiefs are appointed by the governor of the area. Provincial governors are appointed by the central administration.

British officers, appointed by the Egyptian government with the approval of the British government, serve in the departments of finance and the interior. *See also* NILE; SUEZ CANAL. G. C.

EGYPT, ANCIENT. The earliest remains of human habitation in Egypt have been traced back to the Old Stone Age at least beyond 10,000 B.C. Early in the New Stone Age, nomadic tribes were wandering over the land, living by hunting and fishing. Gradually these nomads settled into agricultural communities, cultivating wheat, barley and millet and domesticating animals. Soon they grew highly skilled in the potter's art and learned to fashion stone tools and weapons that have never been excelled in workmanship. From clans gathered around totems, they merged into territorial sections or homes, each ruled by a local chieftain. Some time in the 5th millennium B.C., these homes were organized into two distinct kingdoms: Upper Egypt, extending along the Nile Valley to the Delta; and Lower Egypt, comprising the Delta area.

About 3400 B.C., the kingdoms of Upper and Lower Egypt were united by Mena, with whom the dynastic period begins. Mena's successors of the 1st and 2nd

EGYPT, ANCIENT



COURTESY METROPOLITAN MUSEUM OF ART

ASPECTS OF LIFE IN ANCIENT EGYPT

Theban tomb paintings: 1. "The Vintage," from the tomb of Apuy the sculptor. 19th Dynasty. 2. "The Musicians," from the tomb of Zeser-Ka-Rasonbe, scribe and counter of grain. 18th Dynasty (1415 B.C.).

Area 383,000 sq.m
Pop. . . . 14,493,000

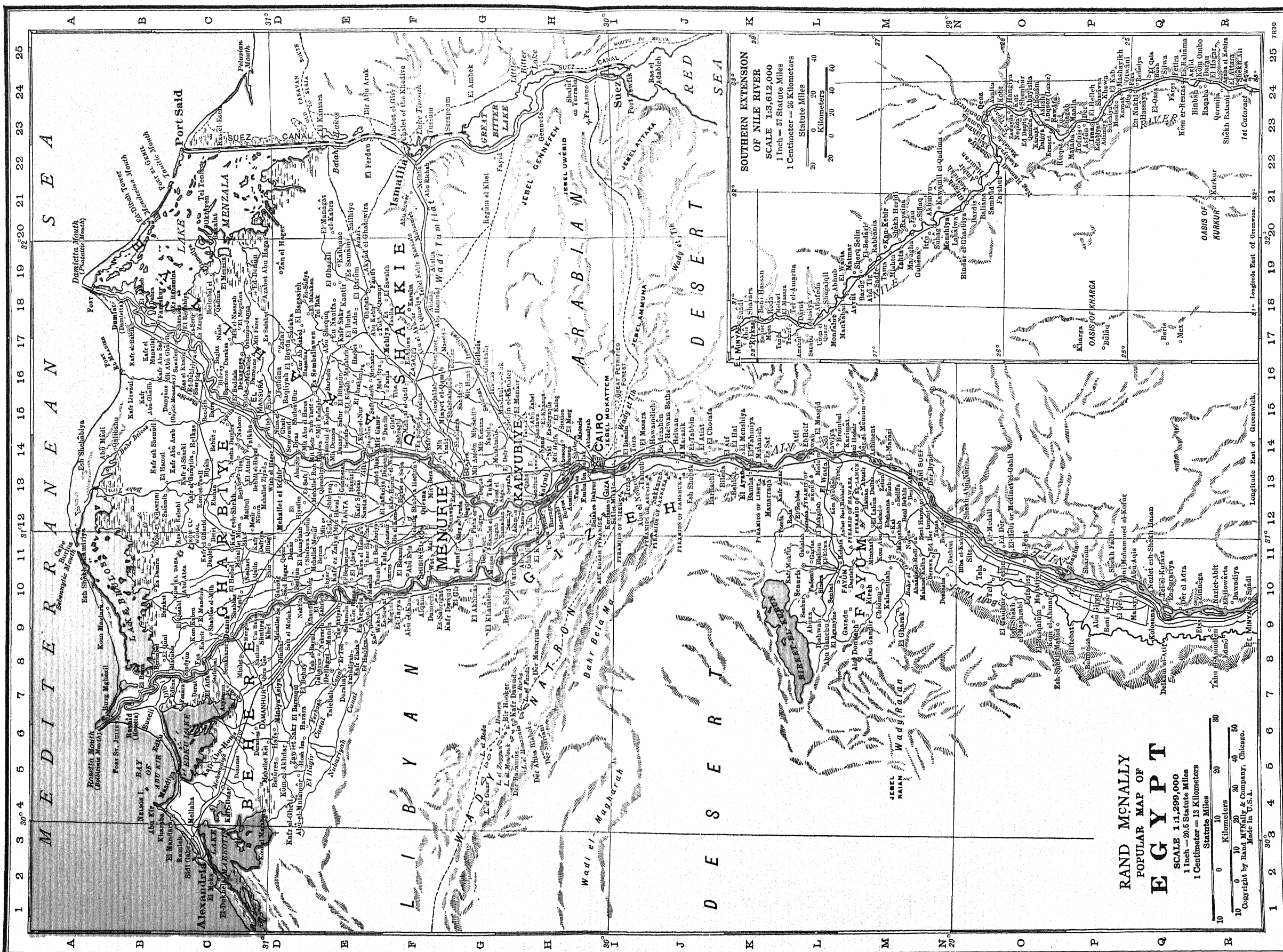
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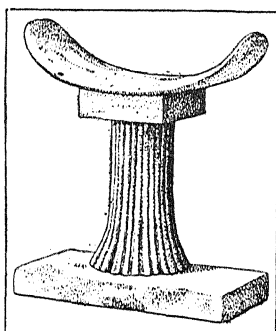
PRINCIPAL CITIES

(Including Figures
from Latest Popu-
lation Estimates)

Pop.—Thousands

- 3 Abd Giring. P 10
- 4 Abu Kebab. E 17
- 2 Abu Sir. D 14
- 6 Abusir. . M 13
- 11 Abd Tig. M 19
- 2 Abu Zabel. H 15
- 22 Akhmyr. . N 20
- 573 Alexandria C. 10
- 3 Amras. . F 24
- 16 Aswan. R 24
- 57 Asyut. . L 18
- 3 Atifi. . N 21
- 8 Bardis. . N 21
- 2 Behbit-el-
Hagar. . D 14
- 4 Belkas. . C 15
- 19 Benha (El-
Arsl). . G 13
- 3 Birket-es-Saba
B. F 12
- 3 Borden. . F 16
- 2 Burg Mghezil
B. B 6
- 1065 Cairou. . I 14
- 52 Damanhur. D 10
- 3 Degua. . G 13
- 2 Derut. . C 8
- 35 Dumia
(Damietta)
B. B 18
- 6 Edfu. B 6
- 6 Edku. B 6
- 18 El Giza. G 10
- 2 El Hawamidleh
J. P 14
- 3 El Helleh. P 13
- 3 El Ibrahimiya
E 10
- 63 El Mansura. . D 15
- 2 El Masara. D 15
- 35 El Minya. K 17
- 3 En Negela. E 10
- 5 Fareskur. B 22
- 10 Farshut. O 18
- 6 Feshn. C 8
- 10 Fua. C 8
- 15 Girgeh. N 21
- 19 Giza. G 10
- 3 Hanut. E 13
- 16 Ismailia. F 22
- 4 Kafr el Battikh
B. B 18
- 9 Kalyub. H 13
- 6 Karaim. F 13
- 3 Karnak. O 23
- 7 Kerdassa. I 13
- 11 Kus. O 24
- 2 Madaya. P 10
- 3 Mataya. Q 10
- 6 Mahallet
Damenne D 10
- 31 Mahallet-el-
Kebir. . D 13
- 4 Mahallet-
Menuf. E 11
- 5 Mahallet Ziyad
D 14
- 29 Malawi. K 18
- 4 Mit Bedr
Halawa. E 14
- 11 Mit Gamr. E 14
- 2 Mit Hawaie
G 14
- 13 Monfalut. L 18
- 6 Nabaro. . C 14
- 5 Nag Hamadi
Hu. O 22
- 2 Nawa. H 14
- 101 Nasr Said. D 10
- 2 Qena. Q 5
- 23 Qena. N 23
- 23 Rashid
(Rosetta). B 7
- 5 Sael Hager D 10
- 3 Samhudd. O 21
- 3 Semenund. D 14
- 11 Sers-el-Liyana
G 12
- 25 Sherbin. O 16
- 3 Shihin-
Khanter G 14
- 25 Shihin-el-Kom
F 12
- 7 Shubra. H 14
- 2 Shubra Khet
D 9
- 36 Suh. I 24
- 22 Suhez. N 20
- 4 Taha Yub. H 15
- 101 Tena. Q 5
- 5 Talkha. D 15
- 90 Tanta. E 12
- 3 Telbana. D 16
- 53 Zagazig. F 16
- 14 Zifte. E 14





COURTESY M. M. OF ART

ALABASTER HEADREST
VI Dynasty (2625-2475 B.C.)

dynasties, about 3400-2980 B.C., lived at Thinis, near Abydos, and proved themselves capable rulers, laying the foundations for the amazing period of prosperity and power that characterized the Old Kingdom, lasting from the 3rd to the 6th dynasties, about 2980-2475 B.C. All the rulers of the Old Kingdom erected huge stone pyramids to serve as their tombs, a custom that was continued under later pharaohs. The famous step pyramid at Sakkara was built for Zoser, a king of Dynasty III, by his remarkable minister architect, Imhotep. At Gizeh are the three mighty pyramid tombs belonging to kings of Dynasty IV; the largest, that of Khufu (Cheops), represents perhaps the finest engineering feat of antiquity. Near by stands the SPHINX, a colossal portrait statue of Khafre, builder of the second pyramid. Under the Old Kingdom, the arts and sciences reached heights hitherto unsurpassed, while the fleets of the pharaohs carried trade to the far-off Phoenician coasts. But at the close of the 6th dynasty, the landed nobles, who had become very powerful, threw the country into turmoil by starting a struggle among themselves for possession of the crown. A long period of darkness followed the fall of the Old Kingdom. Of the 7th and 8th dynasties, mentioned by Manetho, we have hardly any knowledge at all. During the following two dynasties, the throne was occupied by a noble family of Heracleopolis, 18 of whom reigned for a total of 285 years, about 2445-2160 B.C.

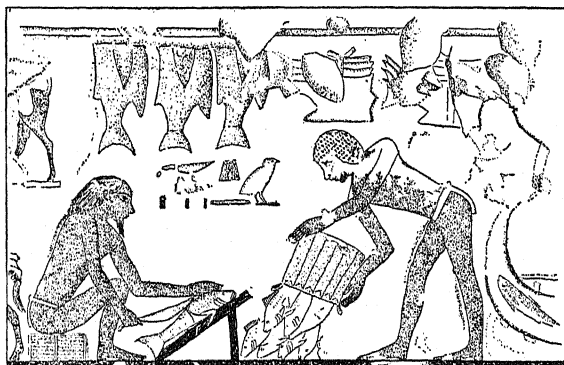


EGYPTIAN THRONE CHAIR

Amen Hotep and his mother. From a wall painting of Thebes of the 18th dynasty, about 1400 B.C.

Golden Age of Egypt. Meanwhile, a strong line of Theban princes was gradually extending its authority in the South to the Delta. These princes

of Thebes finally overcame the northern Heracleopolitans and founded Dynasty XI. They found themselves confronted with the task of subduing the feudal barons, who were ruling their provinces as they pleased, and of centralizing the nation once more. This was accomplished by the 12th dynasty, about 2000-1788 B.C., one of the most brilliant in Egyptian history. It marked the golden age of Egypt, when a deep love for culture swept over the land, which manifested itself particularly in literature. Numerous poetic and religious writings of this period, preserved on papyrus sheets rolled up in jars, have come down to us. Architecture, sculpture and the industrial arts flourished; gigantic irrigation projects were set afoot, and an extensive trade on land and sea was carried on. Amenhemhet I, the founder of Dynasty XII, raised the local god of Thebes, Amen, to the dignity of a national deity. As Amen-Ra, this god was thenceforth to reign supreme over the Egyptian pantheon. Amenhemhet's son, Sesostris I, built many monuments at Tanis, Thebes and Heliopolis. Following the weak reign of Amenhemhet IV, the Government collapsed, and for more than 100 years chaos ruled over Egypt while the feudal lords once more struggled for mastery.



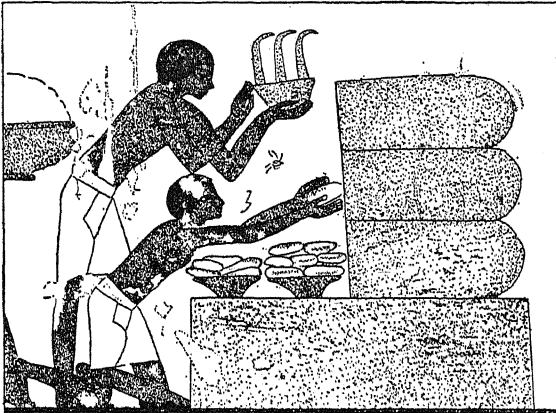
COURTESY METROPOLITAN MUSEUM OF ART

ANCIENT EGYPTIANS CURING FISH
From the tomb of Puy-em-re, second priest of Ammon, at Thebes.
18th dynasty, about 1450 B.C.

Torn thus by internal conflict, the land was easily conquered by a race of Asiatic invaders known as the Hyksos, or Shepherd Kings, who ruled over Egypt until 1580 B.C. Of this confused period of civil strife and foreign domination we know very little except that it had far-reaching effects on later Egyptian history. As has often happened in history, the feudal lords utterly exhausted themselves in fighting against one another, and paved the way for an absolute monarchy. Also, the Hyksos introduced new methods of warfare, such as the war chariot, which helped to transform Egypt into a military empire.

Expansion and Disintegration of Empire. The downfall of the Hyksos was brought about by the rise of a puissant Theban house which succeeded in overthrowing the foreign usurpers and forced them to flee from the country. Now began the long and glorious Dynasty XVIII of Thebes, 1580-1350 B.C., during which the frontiers of Egypt were pushed far into

Palestine, Syria and Phoenicia. For a time at least, tribute was exacted from Mesopotamia and perhaps from some of the Aegean Islands. Incalculable wealth poured into the royal coffers at Thebes, much of which was expended in erecting magnificent temples and tombs and other monuments. The 18th dynasty was distinguished by a line of extraordinary rulers, including the efficient Queen Hatshepsut, who encouraged the peaceful arts; Thotmes III, one of the greatest military and administrative geniuses of ancient times; and Akhenaten (Amen Hotep IV), who



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GATHERING HONEY IN ANCIENT EGYPT

A painting in the tomb of Rekh-Mi-Re, Vizier of Upper Egypt, 18th dynasty, about 1450 B.C.

introduced the cult of the visible sun-disk, which disappeared soon after his death. Under Akhenaten's son-in-law, Tutankhamen, the empire rapidly disintegrated. Most of the conquests of Thotmes III were lost, and there followed a reign of anarchy that involved the fall of the 18th dynasty. In 1350 B.C., Harmhab, an able military commander, usurped the throne and gathered together the remnants of the empire which he handed on to his successors of the 19th dynasty, 1350-1205 B.C. The vigorous efforts of Seti I and Rameses II to regain the lost territories met



COURTESY METROPOLITAN MUSEUM OF ART

HUNTING WITH A CHARIOT IN ANCIENT EGYPT

From the tomb of the royal scribe, User-het, at Thebes, 18th dynasty, about 1430 B.C.

with partial success. Like their predecessors, the pharaohs of Dynasty XIX lavished their enormous wealth in building enterprises, especially at Thebes.

After the reign of Rameses II, several vassal states of Egypt, which had been in continual revolt, shook off the yoke of Egyptian domination, and due largely to this external factor, the country was again thrown into a state of confusion at the end of Dynasty XIX.

The dissolution of the empire was completed under the weak Ramessids of the 20th dynasty, 1200-1090 B.C., who were virtually controlled by the priests of Amen-Ra. When the last king, Rameses XII, died, the throne was actually seized by the high priest Hrihor who, however, was forced to relinquish it soon after to Nesubenebbed, the governor of Lower Egypt. The latter became the founder of the 21st dynasty, 1090-945 B.C., the rulers of which dwelt at Tanis. At the end of their reign, the throne fell into the hands of Sheshonk I, the famous Shishak of the Bible, a commander of Libyan mercenaries who had entrenched himself in the Delta. Under his successors of the 22nd dynasty, 945-745 B.C., Egypt enjoyed temporary prosperity. But the Libyan rulers of the short-lived 23rd, 24th and 25th dynasties, 745-712 B.C., dragged the country into a series of disastrous wars, bringing much suffering upon the people. Here a new element entered Egyptian history in the form of Nubian princes who, goaded on by exiled priests



COURTESY M. M. OF ART

MAKING AN OFFERING BEFORE THE DEITY HORUS

From a Theban stele of painted wood, probably of the 22nd dynasty

of Amen-Ra, invaded and conquered Egypt, forming Dynasty XXV, 712-663 B.C. They soon found themselves involved in continuous wars with the local Egyptian princes who refused to submit to their rule. While thus engaged, Egypt was overcome by the Assyrians, who had now risen to great power, and

for eight years she was forced to pay tribute.

In 663 B.C., Psamtik I, a dynast of Saïs in the Western Delta, was appointed viceroy over Egypt by the Assyrian king, Assurbanipal. He wasted no time in gathering power into his own hands, and soon he was strong enough to expel the Assyrians and make himself king of all the land, founding the splendid 26th dynasty. Under the Saite kings, who ruled until 525 B.C., efforts were made to revive Egypt's ancient glories. Architecture, sculpture and literature, long in desuetude, were once more encouraged. But the artistic productions of this time were, unfortunately, slavishly imitated from the ancient models, and therefore were lacking in originality and character. However, this was a period of comparative prosperity for Egypt. In the reign of Psamtik III, 525 B.C., the Persians under Cambyses overran Egypt, and except for several brief and unimportant reigns of native rulers, the land of the Nile served as a Persian satrapy for nearly 200 years, 525-332 B.C.

After Alexander the Great had defeated Darius III, he marched into Egypt, 332 B.C., and was hailed as a deliverer by the people, taking the country without striking a blow. He proceeded to build the splendid city of Alexandria and made it the capital of Egypt. When he died in 323 B.C., Egypt fell to the lot of one of his trusted generals, PTOLEMY, who made himself king and founded the dynasty of Ptolemies. They developed Alexandria into an important seaport, and one of the greatest centers of culture the world has known. After the Battle of Actium, 31 B.C., and the consequent suicide of CLEOPATRA, the last of the Ptolemies, and Antony, the victorious Octavianus, made Egypt a Roman possession, and as such it remained until the fall of Rome.

A. DE.



COURTESY M. M. OF ART

OSIRIS, EGYPTIAN GOD OF THE DEAD
From a funerary papyrus of about 1025 B.C.

Ancient Religion. The Egyptians worshipped many gods and believed in the immortality of the soul. In the earliest times their religion centered about the worship of the sun, which was represented as Ra. As time went on, their deities became more numerous and were thought to live in the bodies of animals such as the ram, bull, cat, dog and cow. Osiris became one of

the leading gods and round him and Isis sprang up a rich mythology. Man, according to ancient belief, was three separate beings—the mortal man who died, the soul which went to heaven, and the spirit which often returned to the body. Because of this last tenet in their religion, the Egyptians took the greatest care in preserving the bodies of the deceased, skilfully embalmed them, and placed in the tomb many necessities and luxuries of life so that the returning spirit might not want comfort. Many animals were held sacred, not only because they represented a god but also because they constituted the earthly form in which departed souls returned to the earth. But the worship of a particular animal was not generally universal. Sometimes war would be waged because one tribe had killed an animal sacred to another.

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EGYPT, MODERN. During the declining decades of the Roman Empire, Rome depended to a large extent on the fertile Nile valley for its supplies of corn; but the Egyptian peoples continued to be the victims of brutalities and heavy exactions under Roman governors, as they had been victims under previous rulers. The record of Egypt from Roman times onward until well toward the end of the 19th century, in fact, is one long story of wars and oppression, of assassination and religious persecution, of revolts and barbarous crushing of uprisings.

When the Roman Empire broke up, Egypt passed under the control of the Eastern Empire. Christianity spread into the country; followers of heretical Christian sects were persecuted from time to time; strenuous efforts were made to stamp out the old religion; paganism was officially banned in 390 A.D.; the Jews were expelled from Alexandria in 415. The administration steadily deteriorated, and the country fell an easy prey to the Persians when they attacked it in 616. They were ousted by the followers of Mohammed. From 639-968 Egypt was under the Eastern Caliphate. From 969-1171 it was dominated by leaders of the Fatimate sect of Mohammedanism. During this period, Egyptian forces, in an attempt to convert Jews and Christians to Mohammedanism, burned the Holy Sepulchre at Jerusalem in 1010 and destroyed the Christian churches in Egypt. Western Europe came into the picture during the CRUSADES. Egypt lost Jerusalem in 1099. Baldwin I invaded Egypt, unsuccessfully, in 1118. Louis IX invaded the country in 1249, but the next year was captured. A Mongol invasion threatened in 1260.

Incorporated into Ottoman Empire. For practically all of this time, and through the next 200 years, Egypt was the scene of a succession of wars, assassinations, revolts and oppressions. The Mohammedan domination was not threatened; but the Mohammedan sects warred among themselves, and all joined in heavy exactions from the Egyptians. In 1517 Egypt definitely was incorporated into the Ottoman Empire, and what might be called the modern

period began. Mutinies among the mercenary soldiers were common. Revolt followed revolt, due to the heavy tax impositions. The governors, appointed from Constantinople, had practically no authority beyond the area which troops loyal to them occupied.

Napoleon occupied Egypt in 1798; but Nelson's destruction of the French fleet in the Battle of the Nile left the expedition stranded under Kleber after Napoleon's return to France and, in 1801 it surrendered to the British who occupied lower Egypt till 1803. In 1805 Mehemet Ali, the leader of the Albanian mercenaries sent to Egypt by Turkey formally ascended the throne of Egypt, under nominal allegiance to the Ottoman sultan. But in 1831 he revolted again and assumed complete control, becoming virtually independent. The Sultan's effort to dislodge him was frustrated by the victory of Mehemet Ali's forces in 1839. Only the timely intervention by the Western Powers in 1841 prevented the Egyptian ruler from seizing the Ottoman Empire itself. Nevertheless Mehemet Ali again agreed to nominal allegiance to Constantinople, but he secured from the Sultan the right for his family to hereditary succession to the Egyptian throne. Previously the head of the Egyptian Government had been, in theory at least, appointed by the Ottoman caliph.

The modernization of Egypt was started by Mehemet Ali. One of his early acts was to confiscate for the throne all the private land, partly as a means of readjusting taxes, partly to clear up the confusion in land ownership which had developed as a result of the long series of conquests and confiscations of preceding centuries. He pushed the development of industry and foreign trade, though keeping it under his own control. He started the cultivation of cotton on a commercial basis in 1822. He imposed heavy taxes but preserved order and built a number of important public works, including the irrigation barrage across the Nile at the beginning of the delta. He encouraged education and favored the study of European science by Egyptians.

Ibrahim, Mehemet Ali's eldest son, headed the Egyptian Government for a few months in 1848. On his death he was succeeded by Abbas I, who ruled until 1854. Abbas built the railway from Alexandria to Cairo; but during his reign the administration in Egypt deteriorated. His successor, Said, fourth son of Mehemet Ali, who ruled from 1854-63, issued a new land law which guaranteed the fellaheen his freehold on the land against the claim even of the Crown. He also gave the French the concession for the building of the Suez Canal, gave the British the right to open telegraph and cable connections with the rest of the world and to establish the Bank of Egypt, and started the national debt by borrowing from Germans. Said's nephew, Ismail, succeeded in 1863 and ruled until 1879. He began an elaborate series of reforms, but he spent money extravagantly and within 10 years he had exhausted both the resources of the country and his credit abroad. He sold to the British Government his shares in the Suez

Canal company; but this money was only a temporary stop-gap.

British and French Control. Between 1876 and 1878 the British and French, in order to improve order in Egypt and end the chaos in Egyptian finances, carried out a series of investigations followed by reforms which resulted in substantial foreign control of Egyptian affairs. International mixed tribunals were introduced to deal with civil cases, in part replacing the system of consular jurisdiction which was in force in Egypt under the capitulations which applied to the entire Ottoman Empire. Dual financial control was established, with the British regulating collections and the French dominating expenditures. Ismail attempted to throw off the increasing foreign control, and there were disturbances in Cairo. Britain and France appealed to the Sultan at Constantinople, Egypt's nominal overlord, and Ismail was deposed, to be succeeded by his son Tewfik, who ruled until 1892.

Soon after Tewfik came to the throne, the agitation against foreign control took on a more violent form. British and French ships were bombarded by the forts at Alexandria in 1882, and Britain, after inviting first France and then Italy to join with her in taking military control of the country, and after each had refused, acted alone. The succeeding years saw the introduction of many improvements in the administration, the clearing up of Egyptian finances, the construction of a number of important public works, the reduction of taxes, the betterment of the functioning of the courts. But they saw, also, the steady growth of a Nationalist movement in Egypt which showed itself in persistent efforts to secure complete independence and also in increasing opposition to autocratic rule by the King. Two principal issues developed between the Egyptians and the British; the status of the Sudan, and the presence of British troops on Egyptian soil.

The Sudan, lying to the south of Egypt Proper, had been conquered by Mehemet Ali; but the Sudanese had not submitted willingly to Egyptian domination. The region was constantly disturbed. The British finally went in to preserve order. An Anglo-Egyptian convention signed in 1899 provided that the British and Egyptian flags were to be used together in this region, and that some Egyptian troops were to cooperate with the British forces of occupation; but supreme civil and military command was to be in the hands of a British governor general who, while appointed by the Egyptian ruler on the recommendation of the British Government, could be removed only with British consent. This is the basis of the present status in the Sudan. The Egyptian demand is that the region be restored to complete Egyptian rule. The British insist that the Sudan is not properly a part of Egypt, and that in order to keep order there they must maintain control.

With regard to the question of British troops in Egypt, the British position has been and is that the geographical position of Egypt and particularly of the Suez Canal make it vitally necessary that the country be under control which will be friendly to Britain in

order to keep open the communications with the Oriental parts of the British Empire. From this basis, the British argue that, in order to prevent the interference of any other nation in Egypt, they must take whatever steps are necessary to preserve order in that country and to protect foreign lives and interests there, until such time as the Egyptians themselves can carry out these responsibilities. The Egyptian Nationalists have insisted on the right of Egyptians to rule Egypt without outside interference. For a time they were willing to grant that British troops might remain in the Suez Canal zone; more recently, the extremists particularly have insisted that they be withdrawn even from this region. A succession of conferences between Egyptian and British leaders, in London and in Egypt, regularly have broken down over this question of British troops.

Constitutional Conflicts. The conflict between the Egyptian ruler and the Egyptian Nationalists over the degree to which the ruler's power was to be autocratic, developed particularly in the period from 1923-30. An organic law providing for a beginning of Constitutional Government was promulgated in 1883. In 1913 this was changed to provide for a single body legislature with advisory powers, in addition to a Cabinet. In 1923 a Constitution was promulgated, which provided for a Senate, of which the King might appoint two-fifths of the members, an elected chamber of deputies and a Cabinet responsible to the lower house. A series of disagreements between the King and Nationalist leaders, complicated by the inability of the Egyptians and the British to come to any agreement and by outbreaks of violence in Egypt, led to the suspension of the constitutional régime by the King in July 1928. The various Parliaments elected up to that time regularly had been Nationalist by large majorities. The King restored Constitutional Government by decree in Oct. 1929; but the elections in December of that year again gave the Nationalists a large majority. Renewed disagreements between the King and the Nationalists led to another suspension of Parliament in July 1930 and the drafting of a new Constitution which was promulgated Oct. 23, 1930. This cut the Senate membership to 100 and gave the King the right to appoint 60 of the members. Instead of 220 deputies 150 were to be elected by direct vote. The King had the right to suspend sessions of Parliament and to dissolve that body. The Nationalists attacked the new Constitution on the ground that it had not been adopted by the necessary two-thirds vote of both houses of Parliament. Sidky, the premier, maintained rigid control, suppressing freedom of speech and of the press and prohibiting Nationalist meetings and publications. Elections under the new Constitution were held in May 1931, and were accompanied by widespread violence. The Nationalists adopted the policy of refraining from participating in the elections. The new Parliament, in which all the deputies and senators were supporters of the Sidky régime, opened on June 20, 1931. Sidky claimed that in spite of the Nationalist efforts to persuade the

people not to vote, a larger number had participated in the elections than ever before, and that the new Parliament therefore represented Egyptian opinion. Sidky said 1,541,315 voters took part in the May elections. The Nationalists retorted that the real number was not one-tenth of this figure. The Sidky régime vigorously suppressed the violence at the time of the elections, and maintained rigid control of the country in the ensuing months.

Anglo-Egyptian Difficulties. Meanwhile, relations between Egypt and Britain had been developing with increasing tension. When the World War broke out, the Egyptian Government declared for the Allies, though Egypt's nominal sovereign, Turkey, sided with Germany. On Nov. 2, 1914, the British declared martial law in the country. On Dec. 18 Britain assumed a protectorate, and immediately proceeded to depose the ruler, who was in Constantinople, and to put Husein Kamil in his place. Husein died in 1917 and was succeeded by Fuad I. The protectorate was cancelled on Feb. 28, 1922; but martial law was not withdrawn until July 1923.

The Nationalist leaders in Egypt made much of the pronouncements of the Allies about the "self-determination of nations," using these as arguments for Egyptian independence. The British at first refused to negotiate, and arrested, in Mar. 1919, the principal Nationalist leader, Zaghlul Pasha, and some of his associates. Serious disturbances broke out, in which even the Copts joined with the Mohammedans. The British put these down with force, and then sent a commission to investigate conditions and work out plans for the introduction of Egyptian self-government. The commission, which was headed by Lord Milner, spent the winter of 1919-20 in Egypt. Its return to London was followed by negotiations which led to a tentative agreement with which nothing was done. New negotiations in the summer of 1921 broke down on the question of the withdrawal of British troops, and this failure was followed by new anti-British disturbances in Egypt which were rigidly suppressed by the British.

The declaration of Feb. 28, 1922, announced that the British protectorate was terminated and that Egypt was an independent and sovereign state, but reserved to Britain's own discretion the questions of security for British Empire communications, of the defense of Egypt against foreign aggression or interference, of protection of foreign residents and Egyptian minorities, and of the Sudan. Britain also, on Mar. 15, 1922, informed the European powers that she would retain a special interest in Egyptian affairs and that any interference in that country by any other power would be considered an unfriendly act.

The Egyptian Government pointedly refused to accept the 1922 declaration as satisfactory. In the Constitution which was being prepared that year, the Egyptians wanted to call the ruler "King of Egypt and the Sudan." The British insisted that reference to the Sudan be omitted. Zaghlul, premier and head of the Nationalists, conferred with the British premier,

Ramsay MacDonald, in London in the summer of 1924; but once more no agreement could be reached on the basic question of the defense of Egypt. The assassination, in Cairo, on Nov. 19, 1924, of the British governor of the Sudan led to British demands for the complete withdrawal of even nominal Egyptian participation in Sudan affairs, and to a new outburst of anti-British feeling. In May 1926, an Egyptian court acquitted two former ministers of responsibility in connection with the political crimes during the period back to 1920. The British judge resigned in protest against the action of his two Egyptian colleagues, and on June 2 the British Government declared that it would not accept the verdict and that it reserved to itself the right to protect foreigners in Egypt.

King Fuad and the premier, Sarwat Pasha, went to London for further negotiations, in July 1927. A draft treaty of alliance was prepared, but this failed to provide for the evacuation of Egypt by the British troops. The British and Dominion Governments accepted the agreement; but the Egyptian premier, after pigeon-holing the document for months, on Mar. 4, 1928, informed the British that the Egyptian cabinet would not agree to it.

In Sept. 1929, the British made new proposals: that the military occupation be terminated and the British troops withdrawn to the canal zone; that an alliance be formed between Britain and Egypt providing for cooperation in foreign policy and mutual assistance in time of war; that Egyptian legislation be applied to foreigners and the jurisdiction of the consular courts be transferred to the mixed tribunals; that ambassadors be exchanged between Britain and Egypt; that Britain help Egypt to secure membership in the League of Nations; that the status of the Sudan remain as provided in the 1899 convention. The Egyptian Nationalists rejected these proposals as inadequate; but only five extremists in the Parliament which opened in Feb. 1930, voted against further negotiations with the British. The premier went to London in Mar. 1930, and negotiations continued until they ended in failure on May 8. These negotiations started with the 1929 British proposals, which the British said were the utmost they could concede. The Egyptians demanded complete parity in the civil and military administration of the Sudan, a complete end of the capitulations and immediate evacuation of the British troops at least to the canal zone. The Egyptian delegation was received with enthusiasm when it returned. There the matter rested for the time being. The rigid control which the Sidky régime maintained in Egypt prevented further anti-British outbursts, though the demand for complete Egyptian independence continued to be voiced.

Under British domination, Egypt had prospered. The construction of new dams and barrages for getting water from the Nile onto the land, and the reduction of land taxes, had materially improved the condition of the fellaheens who form the bulk of the people. The production and export of cotton, particularly, had grown rapidly and prosperously. But

the fall of the world price of cotton, beginning in 1927 and 1928, created serious difficulties in Egypt. An international conference on the cotton situation was held in Egypt in 1927. In the next four years the Government tried various means to improve the position of the cotton producers, but without appreciable success. The spread of poverty due to the cotton collapse was an important factor in bringing about the continued political disturbances.

G. C.

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EGYPTIAN ARCHITECTURE. The advance of modern research has emphasized the interesting history and unusual significance of Egyptian architecture. Conservative, as any court architecture is certain to be, this style developed almost unaffected from abroad, for 3,000 years, and during this period thrice renewed itself. It initiated the tradition of monumental architecture in cut stone and is the fountain head of our own tradition because of what it taught the Greeks and the Romans.

Important Periods. The dating of Egyptian buildings is by dynasties or groups of kings rather than by years because of several inconsistent chronological systems. The relative dating of the monuments is usually known certainly; but no system of actual dates is fully accepted. The following divisions are based on Weigall: *Predynastic and Dynasties I and II*, c. 5507-2888 B.C. The Early Kingdoms, or city-states were developed by the invaders, perhaps Semites, to whom the later grandeur of Egypt was in the first instance due. Before the close of this period the general character of Egyptian architecture was already fixed, although its history was only begun. Political unification, achieved before the end of this period, made the grandiose later architecture possible, Dynasty I. The oldest cut stonework, the royal tomb chamber of Khasekhemui, Dynasty II, belonged to this period. *Dynasties III-XI*, 2888-2112 B.C. The Old Kingdom, centering at Memphis, produced the first monumental structures in cut stone, the Pyramid group of Zoser, Dynasty III, 2868-2856 B.C.; Imhotep, architect. The Pyramid of Khufu, Dynasty IV, 2789-2767 B.C., was one of the most perfectly built of masonry structures, and it is judged still to be the largest masonry structure. Tombs and motives used and developed in tomb architecture, including remarkable sculpture, are dominant among the remains. Traces of its temple and domestic architecture are scanty. *Dynasties XII-XVII*, 2111-1577 B.C. The Middle Kingdom was a feudal period of preparation for the Empire. The few remains which we have testify to the fine qualities of Middle Kingdom work. *Dynasties XVIII-XXV*, 1577-651 B.C. The Empire, centering at Thebes, marked a period of extraordinary political power and

artistic energy. Under Akhenaton, Dynasty XVIII, there was obvious influence from Crete; but the succeeding dynasties were traditionalist. A somewhat wholesale character crept into their work. Stupendous ruins testify to the activity of Dynasties XVIII, XIX and XX. Temples dominate among the buildings preserved; but there are numerous tombs, rock-cut, and many traces of domestic architecture, not built of permanent materials. *Dynasty XXVI and after, 651-30 B.C.* The Egyptian Renaissance, centering at Sais, and the Ptolemaic Period, after Alexander's conquest. Somewhat free and Baroque in spirit, this revival maintained the integrity of Egyptian forms. 30 B.C. - 400 A.D. Imperial Roman times brought the gradual eclipse of traditional Egyptian architecture.



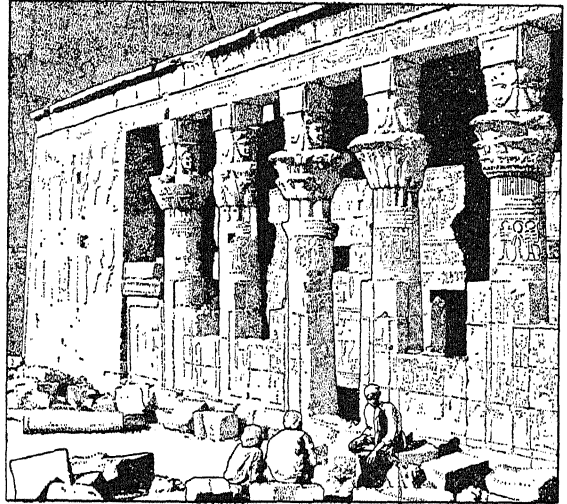
COURTESY M. M. OF ART
OBELISK OF THOTMES III AT HELIOPOLIS, EGYPT

Character of Architecture. As the background of all Egyptian life was the unending line of limestone cliffs which border the Nile Valley, so the background of Egyptian architecture was an unchanging tradition of simple domestic architecture in sun-dried brick with light timber roofs, or in light timber, reeds and clay, well-suited to the rainless climate. It was in primitive examples of this architecture that such characteristic and unmistakable forms as the battered wall, the cavetto cornice, the torus border, the clustered shaft, and the simple geometrical arrangement of plan units, established themselves. And it must be remembered that we have lost the ordinary and palatial domestic architecture based on these simple origins, an architecture in which people lived, remote from the solemn tombs and temples and hardly touched by their majesty. The prevailing note of this popular architecture as indicated by its polychrome decoration was cheerfulness, even gaiety; when it was a foil to the sublimity of the monumental architecture. Post and lintel construction dominated in Egyptian work; moreover arched forms, where they occurred, were so located that they were not much in view.

The Egyptians early produced regular and orderly plans with an emphasis on axial composition in plan. This achievement was combined with another that greatly affected Egyptian ensembles, the well-understood preparation in plan for the principal element. Various elements were skillfully interposed between the entrance to, and the center of, great compositions: thus, in the temples, the sanctuary was often visible as the remote focus of the perspectives of courtyard, colonnade and pillared hall, each progressively smaller and darker in transition to the dim cult chamber. The Egyptians also thoroughly appreciated the overwhelming effect of cut stone masonry in large geo-

metrical forms. The placid massiveness of these monumental forms, so grandly majestic, always communicates a sense of the assured power which created Egyptian architecture.

In the reign of Zozer, Dynasty III, 2868-2856 B.C., it is easy to see that the character of the lighter

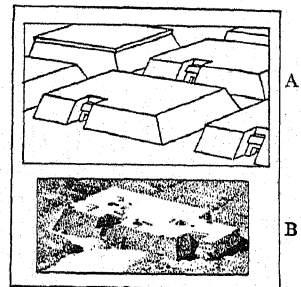


USE OF LINTEL CONSTRUCTION IN THE COURTYARD OF THE TEMPLE OF ISIS, ISLAND OF PHILAE

popular architecture was carried over into the new cut stone style. Then, Dynasty IV, 2789-2716 B.C., there was a reaction toward the simplest forms, for example, the Great Pyramid. Traces of both tendencies are seen in later architecture. In general the forms tended toward simplicity, while the decoration was often profuse.

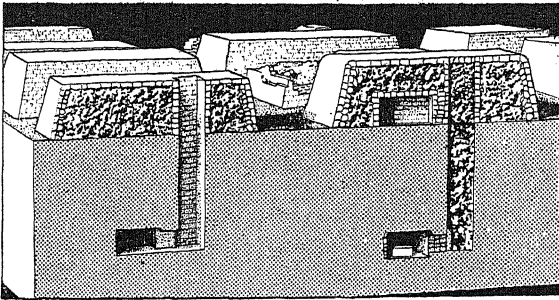
Types of Building. Tombs. From the early times tombs were built by the nobles, who alone could afford it, as permanent structures. Egyptian beliefs in immortality required the preservation of the body. Beginning as a sheathing about a sand mound over the body, the tombs took on the typical sloped-sided bench, or *mastaba*, shape. The offering place developed into an exterior false door, then into a chapel, often vestibuled and regularly decorated with beautiful painted carvings in low relief, relating to the past and future life. A chamber was provided for the immaterial double of the dead and another, at the foot of the shaft, for the sarcophagus containing the body; but both of these chambers were inaccessible.

These elements were used in other tomb forms. Zozer's pyramid, at Sakkara, the oldest, was a new monumental form designed to dignify the pharaoh's resting place by a veritable pile of *mastabas*. Under



FIFTH DYNASTY MASTABAS
(A) Probable appearance of the tombs when built; (B) as they have been restored at Giza

it were extensive chambers and passages, once inaccessible; the chapel was a separate temple. Later royal sepulchres followed this general scheme, and in the mightiest examples it tended to become still

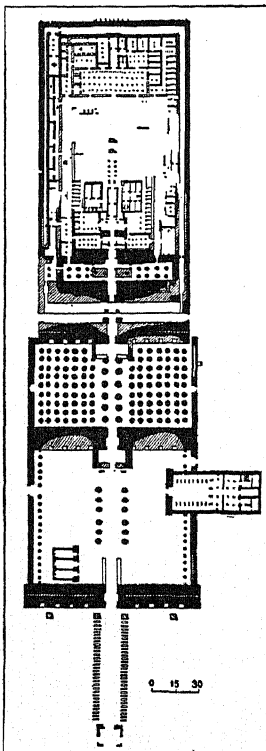


COURTESY M. M. OF ART

MODEL OF AN EGYPTIAN TOMB OF THE 5TH OR 4TH CENTURIES B.C.

more complicated. There were landing stages on the Nile, vestibule temples, and causeways on the way to the temples at the bases of the pyramids built in Dynasties IV and V. In Dynasties XI and XII

shallow rock-cut tombs appeared, chapels with shafts under them, cut into the face of a cliff. The magnificent temple tomb of Mentuhotep, Dynasty XI, at Der-el-Bahri was based on this type, with the addition of a pyramid, porticoes and a garden. Porticoes and terraces gave character to the adjoining temple tomb of Queen Hatshepsut, Dynasty XVIII. Under the Empire the funerary establishments of the pharaohs became still more elaborate, being divided into three independent parts. For the bodies deep rock-cut tombs, galleries up to 450 ft. long with chambers, were excavated and carefully hidden. A complete tomb temple was built at a distance for the ministrations of offerings, and an additional temple might be built elsewhere for the pharaoh's spirit. These changes were evidently made because the older royal tombs had already been violated. In other tombs and in different periods there were numerous interesting combinations of the traditional elements of tomb and temple architecture, mastabas, pyramids, porticoes, terraces, courtyards, rock-cut recesses and galleries, causeways and pylons. The temples often had vast store chambers for



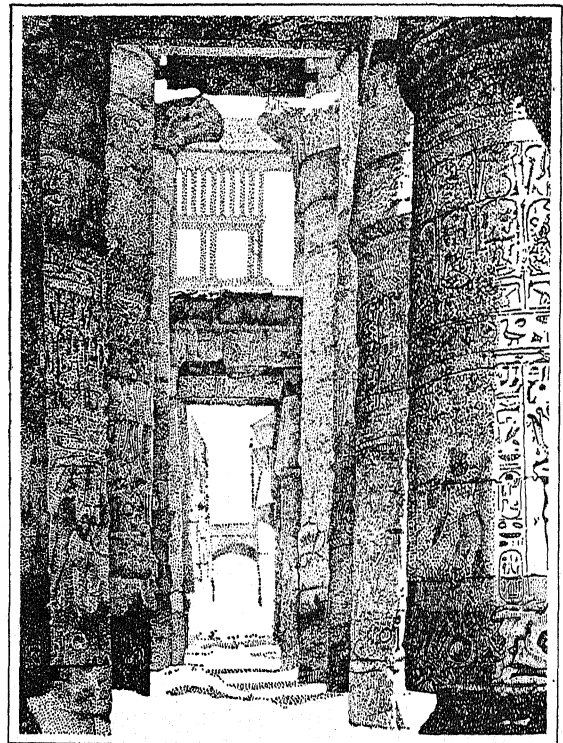
FROM PERROT AND CHUPIEZ, A HISTORY OF ART IN ANCIENT EGYPT

GENERAL PLAN OF THE GREAT TEMPLE AT KARNAK, EGYPT

ready been violated. In other tombs and in different periods there were numerous interesting combinations of the traditional elements of tomb and temple architecture, mastabas, pyramids, porticoes, terraces, courtyards, rock-cut recesses and galleries, causeways and pylons. The temples often had vast store chambers for

tribute; those of the Ramesseum, the tomb temple of Rameses II, Dynasty XIX, were vaulted in brick.

Temples. These consisted essentially of sanctuary cells. Occasionally the cell had a portico around it; sometimes it was multiple, but usually it was surrounded by corridors and sacristies with a processional hall in the rear. In front lay, as a rule, a hypostyle hall, a colonnaded court, and a pylon with a monumental doorway between its two towers, reliefs on its sloping surfaces, masts and statues before it. Hypostyle, court and pylons might be reduplicated in enlarging the temple. Thus there are six pylons at Karnak, the largest of the Egyptian temples, being over 1200 ft. long. It was important from Dynasty XII, but still unfinished, after many additions, in the Ptolemaic Period. The temples were set in sacred enclosures and often approached by avenues of sphinxes. At Karnak there are remains of a mud-brick ramp on which stones were doubtless dragged to the upper part of the building, and there is every reason to believe that this scheme was used in other construction, including that of the pyramids. The hypostyle hall at Karnak, a glorious work of Rameses II, Dynasty XIX,



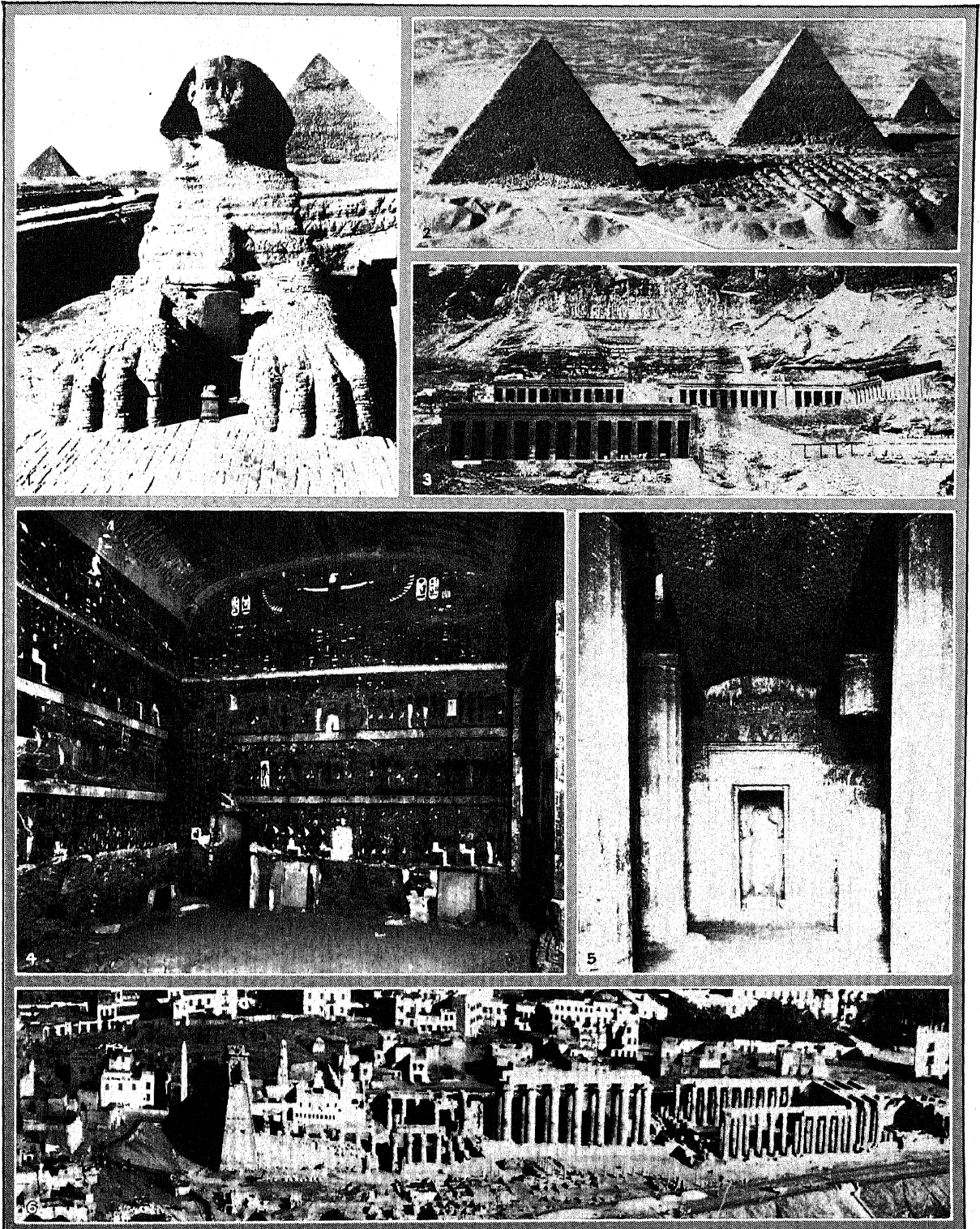
CLERESTORY, HYPOSTYLE HALL

Temple of Amon at Karnak, Egypt. 19th Dynasty

is the most important early aisled hall with clerestory lighting. Certain Egyptian temples anticipated in a way the typical Greek forms. The Sun-temple of Nuserre, Dynasty V, had as its central feature a large obelisk. This was, however, an exception to the usual Egyptian form.

Domestic Architecture. It was customary for each pharaoh to build himself a palace; these buildings

EGYPTIAN ARCHITECTURE



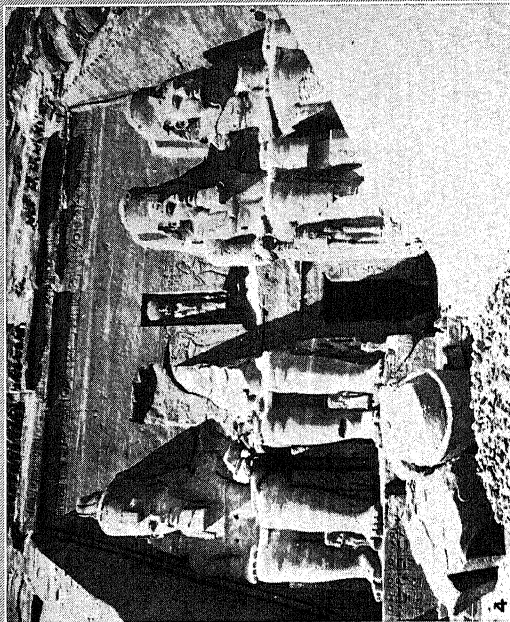
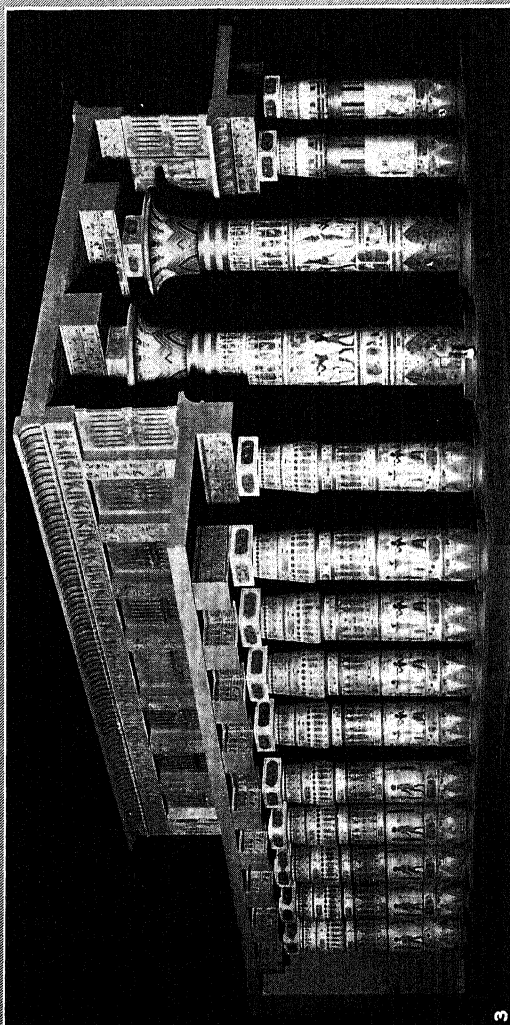
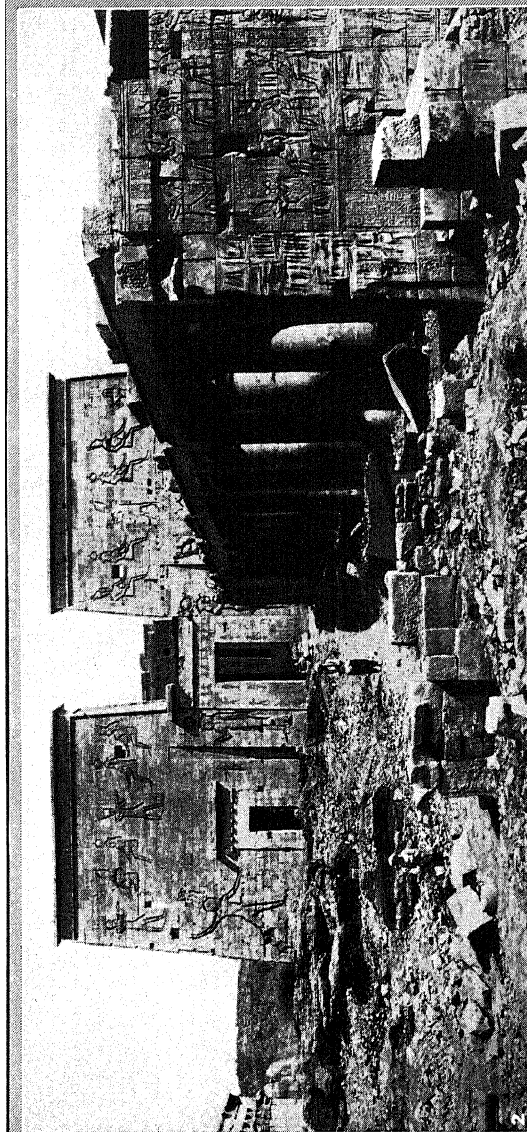
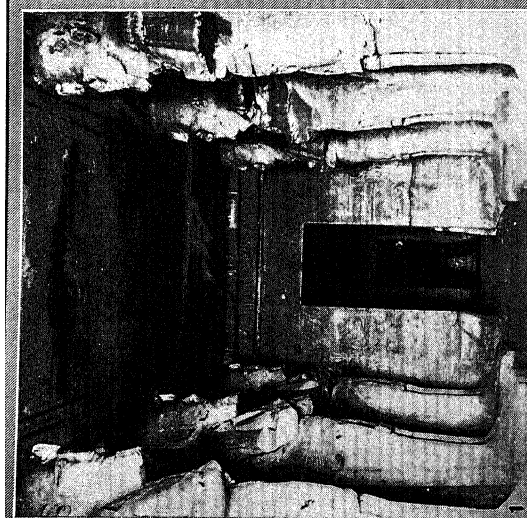
1. R. I. NESMITH AND ASSOCIATES PHOTO; 2. ORIENT AND OCCIDENT PHOTO; 4. EWING GALLOWAY PHOTO; 6. PHOTO BY SIR ALAN COBHAM FROM EWING GALLOWAY

BURIAL TOMBS AND TEMPLES OF THE ANCIENT EGYPTIANS

1. The Sphinx at Giza. 2. Great Pyramid of Cheops and second pyramid of his brother Cephren. Rows of mastaba tombs are at the base of the latter. 3. Terraces and porticos of the Temple of Hatshepsut at Deir el-Bahri, Thebes.

4. Interior of the Tomb of Seti I, Thebes. 5. Interior of the Tomb of Amenemhet at Beni Hassan, noted for its wall paintings and 16-sided columns. 6. The Temple of Luxor, on the Nile. 18th dynasty.

EGYPTIAN ARCHITECTURE



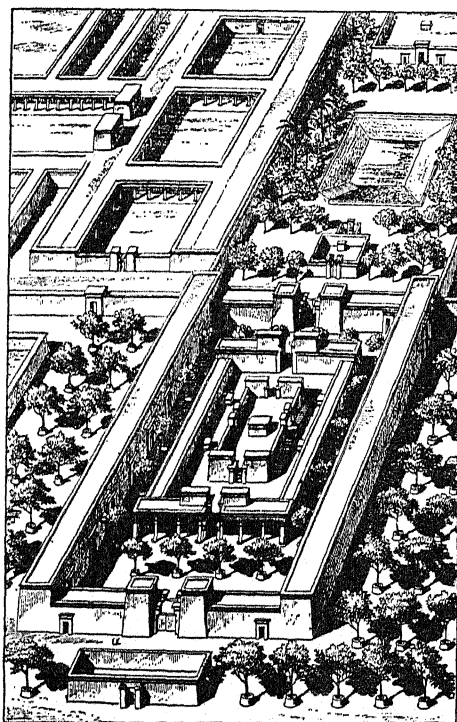
3. COURTESY METROPOLITAN MUSEUM OF ART; 4. EWING GALLOWAY PHOTO

TEMPLE ARCHITECTURE OF ANCIENT EGYPT

1. Colossal statues of Rameses II in the hypostyle hall in the Great Temple at Abu Simbel.
2. Outer temple court and first pylon of the Ptolemaic Temple of Isis on the Island of Philae in the Nile.
3. Model of the hypostyle hall of the Temple of Karnak, showing the columns with bell- and lotus-bud capitals.
4. Colossal statues of Rameses II on the façade of the Great Temple of Abu Simbel. 19th dynasty.

were therefore not designed for permanence, and only slight remains of them exist. They were often vast symmetrical layouts including courts and pillared halls; the decorations were largely painted on stucco. At Tell el-Amarna the plan of the palace of Tut-ankhamen, Dynasty XVIII, has been recovered. There are nine principal divisions, marked off by a straight line in a rectangle: an outer court above which the pharaoh could show himself to the people, and sacred enclosures to either side; a central court with a menagerie at one side and offices on the other; the pillared state apartments, with the harem to one side, feasting rooms and functionaries' apartments to the other. Other examples show less rigorous plans. At Medinet Habu a vaulted palace for the pharaoh adjoined the temple, Dynasty XX.

For the magnates extensive villas were built. These had grounds laid out in a formal way, according to representations in the tombs. Excellent material for the study of these and smaller establishments is preserved at Tell el-Amarna, Dynasty XVIII, about 1400 B.C. The more ordinary Tell el-Amarna houses had walls of sun-dried brick. They were entered through



PERROT AND CHIZE, HISTORY OF ART IN ANCIENT EGYPT

PARTIAL RESTORATION OF PALACE AT
TELL EL-AMARNA, EGYPT

a porch and antechamber; from the central hall with hearth and bench thus reached, the suites assigned to the master, to the men and to the women of the household were accessible. Some establishments had separate chapels and offices. The plans were simple and lacked the symmetry of the larger ensembles. Other interesting examples are presented at Illahun, a closely-knit town of Dynasty XII, for pyramid builders.

A regular area was subdivided in an orderly manner for large, medium-sized, and small houses built all at once. Beside this work must be put the still freer houses built of timber and reeds. These, to judge by tomb carvings, were much more interesting on the exterior than the buildings made of sun-dried brick. The traditional simplicity of the poorer quarters has already been noted.

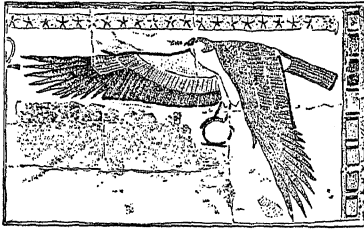
Military Architecture. As sun-dried brick was used in military architecture few remains have been left. The walls were massive, and probably from early times conceived as curtain walls between projecting towers, from which an attacking party could be taken in enfilade. The forts of Semnah and Kummeh, Dynasty XII, were large platforms with buttress-like projections for this purpose.

Materials and Structure. From the cliffs bordering the Nile the Egyptians drew limestone, in the north; sandstone, on the middle river, and granite, in the south. The quality of the stone was often excellent, and means were developed for extracting large blocks. The Great Pyramid of Khufu consists of about 2,300,000 limestone blocks averaging $2\frac{1}{2}$ tons each, which were quarried, ferried and dragged into place in yearly three-month campaigns covering the space of 23 years. Other large enterprises involving similar though smaller effort were taken as a matter of course in Egypt. The actual structure of monumental buildings in stone was invariably post and lintel, though sometimes arched forms were carried out in slab construction; occasionally, too, arched forms were used in rock-cut architecture. Stone buildings of monumental character never had wooden roofs as far as we know; the Egyptians preferred the encumbrance of many heavy stone supports to the impermanence of wooden carvings. They never used their stone to anything like its full strength. In the Empire Period and later the execution was often somewhat careless, but the cutting of Old Kingdom stonework has rarely been surpassed. The best work was laid without mortar, metal clamps being used.

The Egyptians had to import their heavy timber, cedars from Lebanon. Palm, sycamore and tamarisk grow in Egypt, and all were sawed up for use. Papyrus supplied reeds in abundance. Earth suitable for sun-dried brick was available everywhere. Vaults, chiefly in tombs and store chambers, were commonplace from Dynasty III onward, but they very rarely occurred in stone. In the dry Egyptian climate sun-dried bricks last almost indefinitely; bricks known to be about 4,000 years old were reused by an archaeological expedition recently.

Decoration. Buildings for the gods or the dead had walls and even columns covered with a profusion of figure carvings in "sunk relief," intended to be painted in conventional colors. Some of these are very noble. Similar objects occur in fresco, and painted pavements are found in the palaces. In addition, the Egyptians had an extensive repertory of ornament derived from plant sources, notably the lotus, palm and papyrus. The typical Egyptian

columns in stone, lotus-bud, campaniform and palm-leaf, obviously owed their inspiration to these plants; but there was in addition the overloaded Hathor-headed column. In lighter material the columns were



COURTESY M. M. OF ART

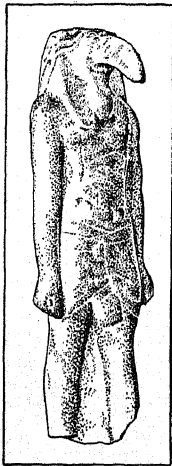
HORUS OF EDFU

Painting from the Temple of Hatshepsut, Thebes, of the 18th dynasty, about 1485 B.C.

often fanciful assemblages of plant forms. Gay earthen colors were profusely used in a way which would produce a riotous effect in a less sunny country than Egypt.

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EGYPTIAN ART. The art of Egypt was closely linked to the desire of the people to erect enduring abiding-places for their dead, and to provide the departed with necessities for the life to come. As an ancient historian aptly remarked, the Egyptians looked upon their houses merely as places of passage, and their tombs as their permanent dwellings. Most of the remains of their art and architecture are associated with these tombs, monuments of their quest for eternity.



ALABASTER STATUETTE OF THE IBIS-HEADED GOD, THOTH

A characteristic structure of early Egypt is the royal tomb, which took the form of a pyramid. There are about 100 of these pyramid-tombs remaining in varying states of preservation, the most famous being the group of three at GIZA which belong to kings of the Fourth Dynasty (c. 2900 B.C.). Among them is the mighty pyramid of Khufu (Cheops), which rises to a height of 481 feet, the base having been originally 775 feet square. In the heart of this pyramidal mass, built largely of huge blocks of limestone, was a granite chamber containing the mummy of Khufu. The building of this tomb represents one of the most

remarkable architectural and engineering achievements of the ancient world.

While pyramids were erected for kings, officials of high rank were entombed in mastabas, which were rectangular structures of limestone or sun-dried brick, with the sides sloping inward, and having flat tops. Some of these mastabas contain genuine arches prov-

ing that the principle of the arch, although little used, was known to the ancient Egyptians. Still another type of sepulchral architecture, prevalent during the Middle Empire, was the rock-cut tomb, hewn out of the living rock. The famous tombs at Beni-Hassan are of this type.

Egyptian architecture is impressive because of its imposing massiveness, but it lacks grace and beauty. This is true of both temples and tombs. Heavy walls and close groupings of columns, together with flat roofs and predominantly straight lines, give the buildings an air of awe-inspiring solemnity, but not of beauty. This is well illustrated by the celebrated temple at Karnak, in which the hypostyle hall contains 134 columns, some rising 70 feet in height.

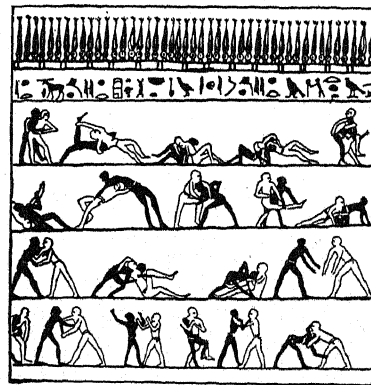


COURTESY M. M. OF ART

WORSHIPPER BEFORE BES

Bronze group of a late Egyptian dynasty

Egyptian sculpture is chiefly known for its extreme simplicity and grandeur of style. Both these qualities are contained in the outstanding sculptural monument of Egypt, the colossal stone Sphinx which crouches in the desert at Gizeh. Numerous statues and statuettes in stone, bronze, terra cotta, wood and other materials, representing gods, human beings and animals, have been discovered in temples and tombs. Although possessing a realistic quality, Egyptian sculpture presents a picture of monotonous uniformity. It was bound by the shackles of rigid conventionality that characterized all

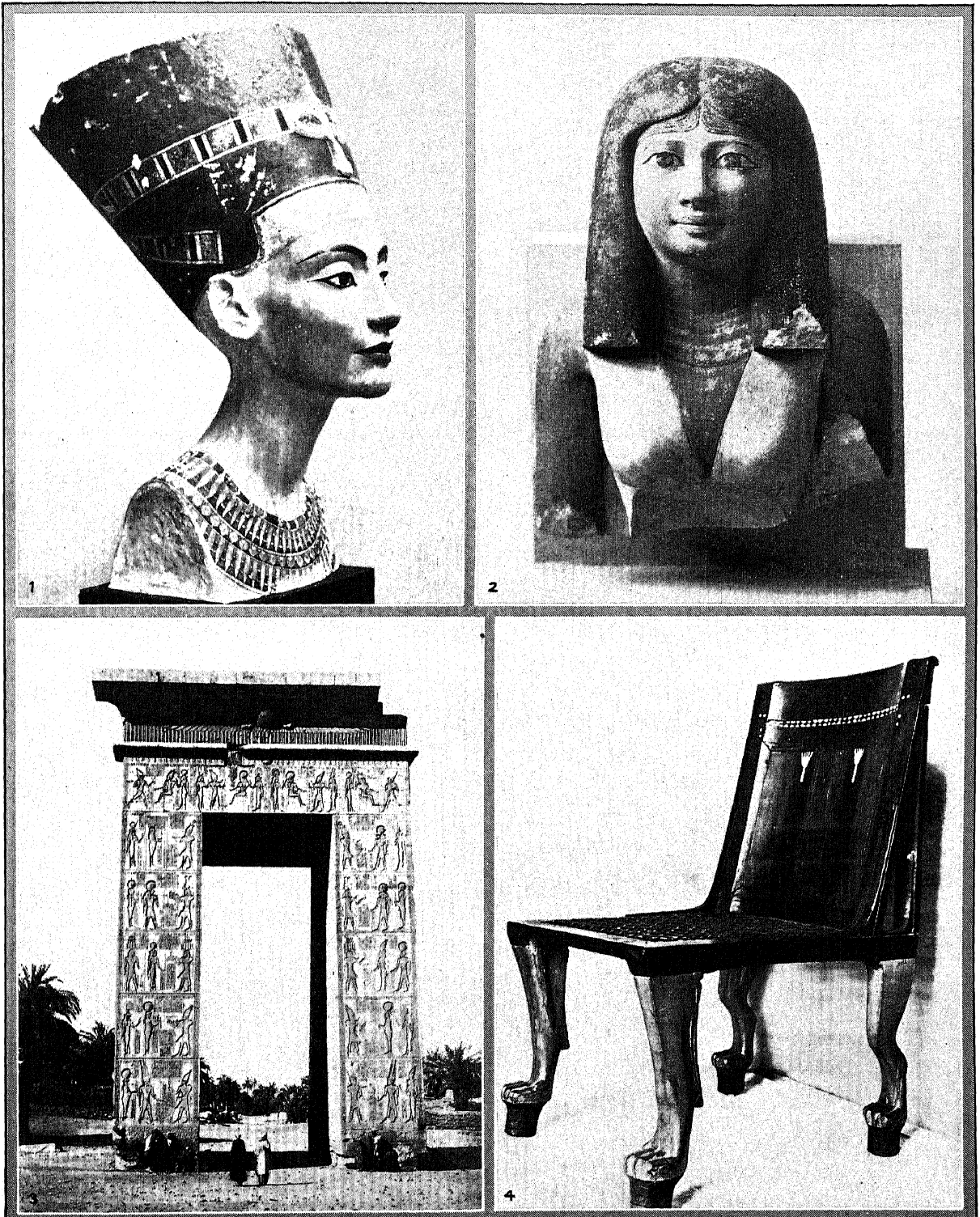


COURTESY EGYPTIAN EXPLORATION SOCIETY

WALL PAINTINGS OF THE TOMBS AT BENI HASSAN, SHOWING WRESTLING HOLDS OF THE ANCIENT EGYPTIANS

phases of Egyptian culture. Everywhere there is endless repetition, as in the celebrated avenue of sphinxes at Karnak, the same fixed expression, the same attitude, the same attributes. Also, whether the subject sits, stands, kneels or squats, the body and head always face directly forward. This monotony of style is also revealed in relief sculpture, which was a favorite form of surface decoration in ancient Egypt. Low reliefs usually representing scenes from mythological, histori-

EGYPTIAN ART



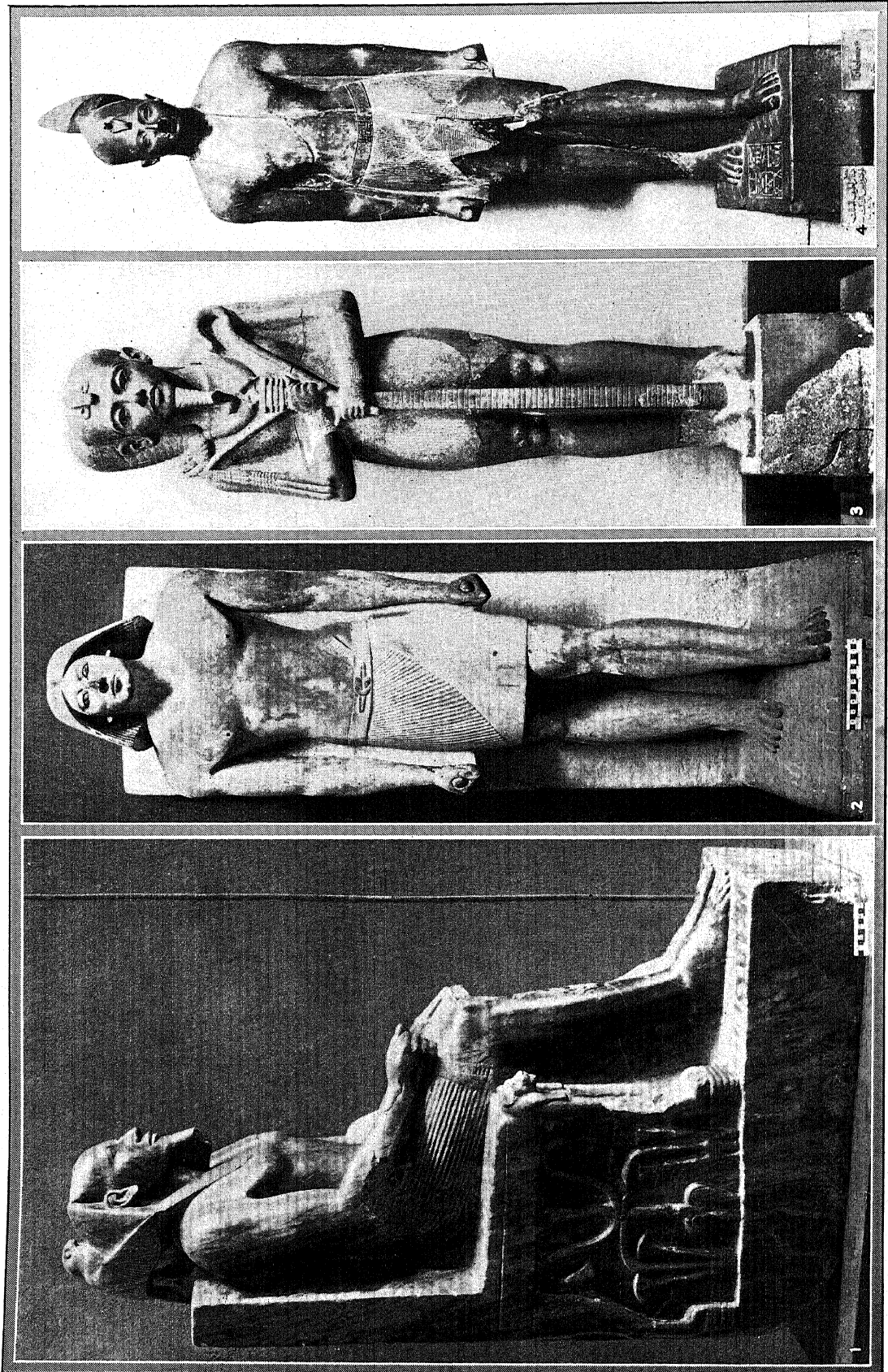
1. 2. COURTESY METROPOLITAN MUSEUM OF ART

SCULPTURE, RELIEFS AND FURNITURE OF THE EARLY EGYPTIANS

1. Facsimile head in painted limestone from Tel el-Amarna of Nefertiti, queen of Akhenaten, ruler of the 18th dynasty. The original is in the Berlin Museum. 2. Statuette of a woman of the 4th dynasty in painted limestone; nat-

ural hair was placed under the heavy wig. 3. Portal of Ptolemy carved in heavy relief at the Temple of Khonsu, Karnak. 20th dynasty. 4. Chair of the 18th dynasty, in the Museum of the Louvre, Paris.

EGYPTIAN ART

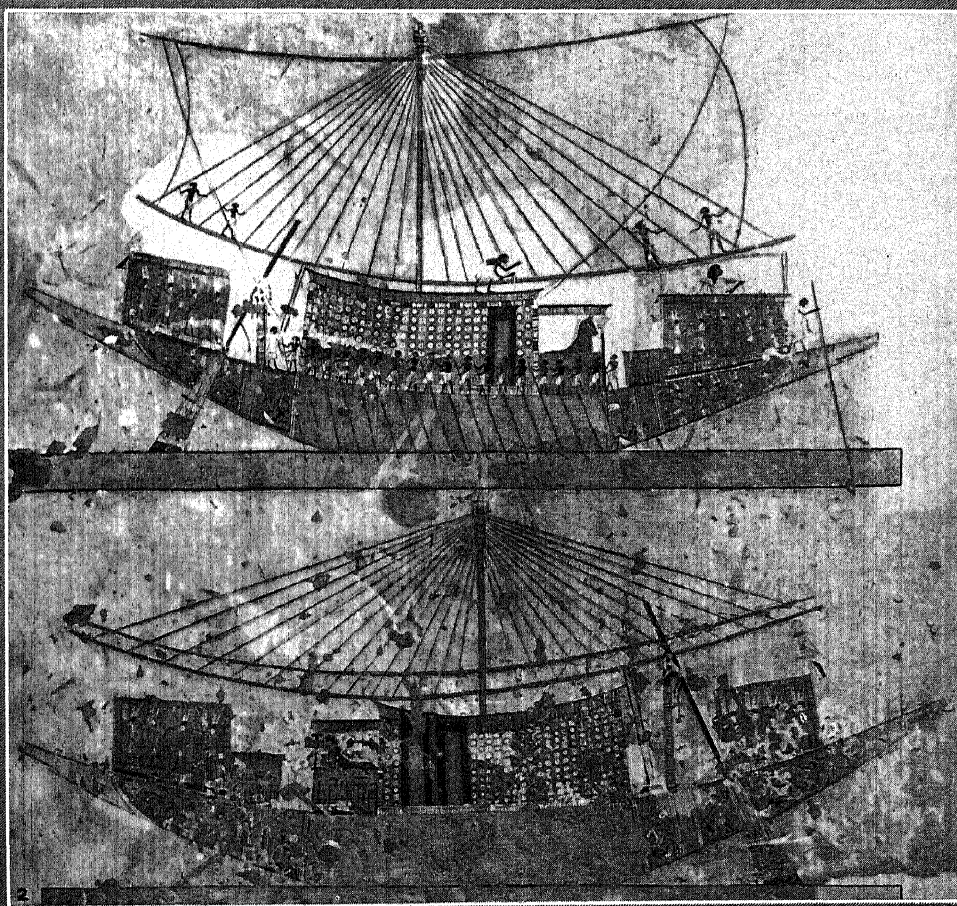


FROM PHOTOGRAPHS OF THE ORIGINAL STATUES IN THE CAIRO MUSEUM

SCULPTURES FROM EGYPTIAN TOMBS

1. King Khafra (Chephren), 4th dynasty, a statue of polished green diorite from Giza.
2. Ranofer, priest of Ptah, 5th dynasty, statue of painted limestone from Sakkara.
3. King Tutankhamen, 18th dynasty, a red granite statue from Karnak.
4. King Thotmes III, 18th dynasty, a basaltic statue from Karnak.

EGYPTIAN ART

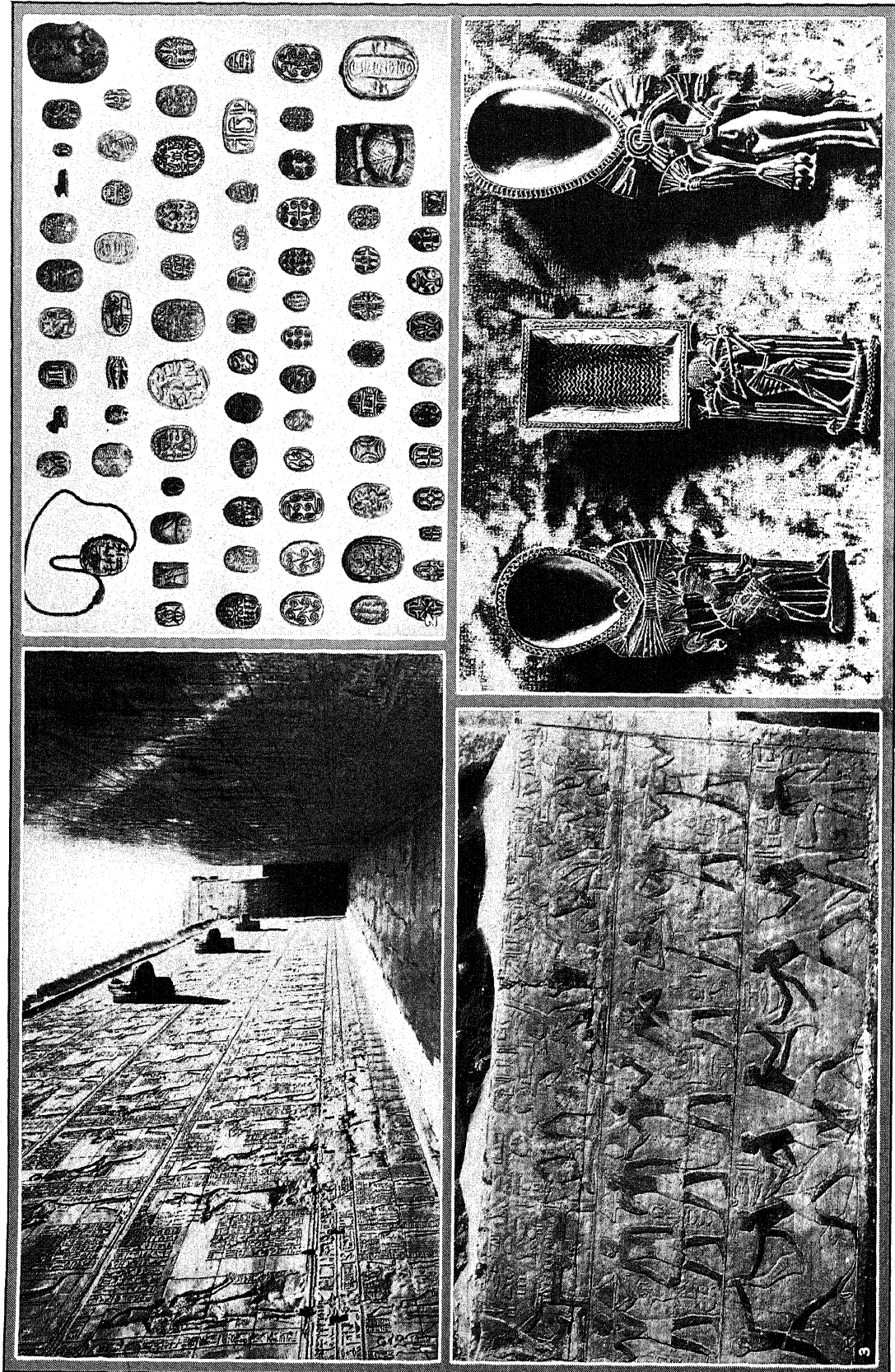


COURTESY METROPOLITAN MUSEUM OF ART

THEBAN TOMB PAINTINGS OF THE EIGHTEENTH DYNASTY

1. Fishers and fowlers of early Egypt, from the Tomb of Menana, Scribe of the Fields of the Lord of Two Lands,
2. Two views of the Viceregal *Dehalryeh*, from the Tomb of Huy, Viceroy of Nubia under Tutankhamen,

EGYPTIAN ART



2, 3. COURTESY METROPOLITAN MUSEUM OF ART; 4. GIRAUDON PHOTO

ART AND DECORATION OF THE EARLY EGYPTIANS

1. Corridor carved in relief in the Temple of Horus at Edfu.
2. Examples of the jewelry of the Egyptians; scarabs, gems and seals decorated in hollow relief.
3. Panels representing slaves carrying offerings to the temple, a detail from one of the mastaba tombs of Sakkara.
4. Metal spoons from Thebes. 18th dynasty.

cal and domestic life, and often brilliantly painted, covered the walls and columns of the great structures.

Painting was hardly an independent art in Egypt, being usually employed to decorate the surfaces of architectural and sculptural works. Although the Egyptian artists had no knowledge of perspective, and their figures lack ease and naturalness, the decorative quality of their mural paintings is well-nigh perfect.

In the minor arts, pottery, jewelry, enamel- and metal-work, the Egyptians showed a high degree of craftsmanship, and their works still furnish inspiring examples to modern artisans.

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EGYPTIAN LANGUAGE, an extinct language of the Hamito-Semitic linguistic family preserved in texts from at least 3000 B.C. until in the 17th century it disappeared as COPTIC.

The ancient Egyptian language is understood but can be read only imperfectly, for the script indicates consonants alone, and the values of some of them are not yet determined with complete accuracy. This early script consists of pictographs called "hieroglyphs," the most common being about 600 in number, and representing human beings, parts of the body, animals, plants, utensils, etc. The majority are at once ideographic (*see* IDEOGRAM) and phonetic, expressing either words of one, two, or three consonants, or parts of other words containing that consonant or these consonants (as if, e.g., the picture of a man could be read either as "man" or as *man-* in the word "manage"), and some hieroglyphs serve as ideographic "complements" (as if the sign for "man" used before the hieroglyph for "people" should give the specification for "men"). This system, whose tradition had been lost, found decipherment, by J. F. CHAMPOLLION in 1822, only by the help of the bilingual ROSETTA STONE in Greek and both hieroglyphic and demotic Egyptian.

The earliest form of the language, that of the Old Empire, about 3400-2200 B.C., is known almost solely by hieroglyphic texts. During the Middle Empire the classical language which had already been formed continued to be written on stone in hieroglyphs, but manuscripts written in ink on papyrus show a much simplified hieroglyphic cursive called "hieratic," while, in non-religious texts, the language undergoes modification. Under the New Empire, after 1580, this vernacular (New Egyptian) sometimes replaces the classical in hieroglyphic inscriptions. In the 6th century B.C., although the classical dialect is still generally written on stone, the manuscripts reveal a language more and more changed; while the script is a new and even more simplified cursive hieroglyphic in which some indications of vowels appear, this being the so-called "demotic" language and alphabet.

M. C.

BIBLIOGRAPHY.—A. Erman, *Ägyptische Grammatik*, 4th ed., 1929; A. Gardiner, *Egyptian Grammar*, 1927.

EGYPTIAN LITERATURE, ANCIENT. In ancient Egypt three forms of writing were used. Of these, the oldest was the hieroglyphic, a form of picture writing supposedly invented by the god Thoth; the priestly writing, it appears on ancient tombs and monuments, and was used by Egyptians until the 1st century B.C. A second kind, the hieratic, employed the hieroglyphic characters in an abbreviated form, and was used by the priests for writing on papyrus. The popular script was the demotic, an abbreviated form of the hieratic. Developed in about 700 B.C., it was in general use for secular writing down to the Roman period. The key to the three ancient languages was discovered in 1798-99 in the ROSETTA STONE.

The main body of the ancient literature was produced during the Middle Kingdom (3000-1600 B.C.), and consists of inscriptions on tombs and monuments and a large collection of papyri, many of which are copies made in later times. The most important single survival is perhaps the religious work called the BOOK OF THE DEAD, a collection of maxims for the guidance of souls after death. Of the ancient mythology, which was undoubtedly very rich, there are only a few remains. In philosophy, the most valuable survivals are the various collections of proverbs, as *The Proverbs of Ptah-hotep*, the *Papyrus Prisse* and *The Prescriptions of Ani*. A few scientific works remain, notably the *Rhind Papyrus*, on mathematics, about 1600 B.C.; the *Papyrus Ebers*, on medicine; and the *Harris Magical Papyrus*. Of the ancient poetry all that survives are a few love songs and hymns, and an epic celebrating a victory of Rameses II's.

By far the most interesting relics of ancient Egyptian literature are the various collections of stories and tales—somewhat on the order of the *Arabian Nights*. While many of these stories are tiresomely repetitious and rhetorical, many others are straightforward narratives told simply and with great charm. One of the most famous of these is the *Papyrus Westcar*, ascribed to the Middle Kingdom.

The period of ancient Egyptian literature may be said to close with the Greek conquest of the country in 332 B.C.

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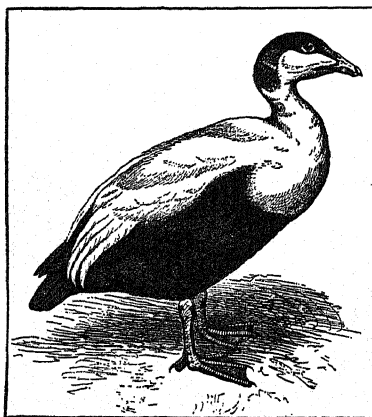
EHRlich, PAUL (1854-1915), widely known as a chemist, became assistant in the Institute of Robert Koch and in 1896 director of the Institut für Serum Forschung at Steglitz in Germany. Under his direction, this was transferred in 1899 to Frankfurt-on-the-Main, where it became the Institut für experimentelle Therapie. He is widely known for his studies of dye-stuffs and tissue staining, but particularly for having discovered the substance called "606" or salvarsan, and now known as arsphenamine, which is a specific in the treatment of syphilis. He developed later the substance called "914" or neosalvarsan. During his life-

time he developed other methods of treatment, including his introduction of such remedies as methylene blue for quartan fever, trypan red for bovine piroplasmiasis, arsenophenylglycin for the trypanosomiasis; his proof that animals can be quantitatively immunized against vegetable poisons like abrin and ricin; his improvement of Behring's diphtheria antitoxin and his establishment of an international standard of purity for the same; his demonstration that cancer can be changed into sarcoma in animals by successive inoculation, and that the growth of cancer depends upon the presence of certain food substances in the body and that immunity from cancer depends upon their absence (atrepsy); his vast researches in the whole field of serology and immunity can only be mentioned. M. F.

EICHELBERGER, WILLIAM SNYDER (1865-), American astronomer, was born at Baltimore, Md., Sept. 18, 1865. He graduated from Johns Hopkins in 1891, and from 1898 to 1929 he was associated with the United States Naval Observatory, taking part in the eclipse expeditions to Pinehurst, N.C., in 1900, to Sumatra in 1901 and to Daroca, Spain, in 1905. In 1929 he became associated with the Eastman Kodak Company, Rochester, N.Y.

EIDER, the common name for a genus (*Somateria*) of strong-winged sea ducks of cold northern regions, famous for their fine soft down. They are birds of large size, the males with handsome black and white plumage varied with buff and pale green, the females brown. The eiders live mostly on the open sea where they feed largely upon mollusks and crustaceans, but at the breeding season they come to land, nesting on rocky islands and shores. The female lays five to eight olive-green eggs which she covers with down plucked from her breast. This down is the valuable eider down of commerce, highly prized for making bed-coverings.

The European eider (*S. mollissima*) breeds in large



EUROPEAN EIDER

numbers in the arctic regions of the Old World, as far south as the British Isles. Its down is procured largely from Norway and Iceland where, protected and provided with artificial nesting sites, the bird

becomes partially domesticated. The Greenland eider (*A. m. dresseri*), which breeds from Labrador northward and winters southward to Maine, also furnishes commercial eider down.

IEFFEL, ALEXANDRE GUSTAVE (1832-1923), French engineer, born at Dijon Dec. 15, 1832. He is known for his use of iron in the construction of bridges and viaducts. His name is associated with the iron tower at Paris which he built in 1889. Eiffel also constructed for the Paris Exposition of 1878 a pavilion and the main façade. He died Dec. 28, 1923.

IEFFEL TOWER was constructed of interlaced iron work in 1887-89 in the Champ-de-Mars, Paris, opposite the Trocadéro, by the engineer Alexandre Gustave Eiffel as a monument for the International Exposition. Rising to a height of 984 ft., this structure was the highest in the world until the completion of the Chrysler Building in New York (1,046 ft.) in 1930. The Eiffel Tower is built on a quadrangular base of masonry 141 yds. square from which rise the four inclining uprights united beneath the first platform by round spans; these girders gradually approach as they ascend, and at about 590 ft. become a single shaft. A staircase ascends to the first platform, 190 ft. above the ground; the second platform, reached by elevator, is at the 380 ft. level; the third, 905 ft. from the ground, supports a glass pavilion 54 ft. square. Within the lantern, which rises 79 ft. higher, a staircase ascends to a circular balcony where the view extends 55 mi. in a straight line. The tower is important as a meteorological and wireless telegraph station. Time signals and weather and crop reports are broadcast from it daily.

EIGHT-HOUR DAY, in American economic parlance, has three separate meanings: 1. a straight or actual 8-hour day, under which eight hours only are worked, with overtime restricted or prohibited, the work week usually consisting of 48, 44 or 40 hours; 2. the 8-hour day may mean an 8-hour shift. In continuously operated industries there are often three 8-hour work periods and three different sets of workers. Under this arrangement overtime is practically eliminated. It is primarily an arrangement for securing greater efficiency, the alternative being two shifts of 12 hours each, an alternative which has proven inefficient; 3. the so-called basic 8-hour day, in which eight hours is a basis for wage payment and overtime is usual or permitted at an increased rate of pay. In this case, although the normal work week may consist of 48, 44 or 40 hours, there is no limit to the number of hours which may be worked overtime. The basic 8-hour day is essentially a wage issue, a standard by which to measure services. The Adamson act which fixed a basic 8-hour day for train service employees, fixed the same rate of pay for a minimum of eight hours as was formerly paid for ten hours and states "Eight hours shall be deemed a day's work and the measure or standard for the purpose of reckoning compensation for the services." This law has operated however to reduce actual hours nearer the eight hour limit.

Organized labor first fixed May 1, 1886, as the time limit for the establishment of the 8-hour day. The carpenters were among the first to win it on a national scale. Since that time, through STRIKE or peaceful negotiations, it has gained steadily until now, the 8-hour day, the 48 hour week, with at least one complete day's rest in seven is accepted as the international standard for all industrially developed countries, and has become the subject of legislation in many.

Eight-hour legislation in the United States, first passed to protect women and children, was later extended to men in public work, and in hazardous occupations. It received great impetus during the World War when government contracts called for an 8-hour day and government labor boards fixed eight hours a day as a basis of computing compensation.

Scientific studies of FATIGUE IN INDUSTRY in relation to hours and output have helped enlightened employers to realize that excessive hours are unsocial and inefficient, and the 8-hour day has become so general that LABOR ORGANIZATIONS have turned their attention to the 5-day, 40-hour week. See also LABOR, HOURS OF. P. F. B.

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EINDHOVEN, a city in the Dutch province of North Brabant, located at the confluence of the Einde and the Dommel. It manufactures cotton and woolen goods, linen, hats, lace, cigars, cigar boxes, matches and electric bulbs. Pop. 1930, with suburbs, 95,567.

EINHARD or **EGINHARD** (c. 770-840), biographer of Charlemagne, was born in Austrasia about 770. (See also CHARLEMAGNE.) His outstanding scholastic ability led to his being sent to the school in the palace of Charlemagne. He became secretary to the emperor and held many other important official positions. His chief work is the *Vita Caroli Magni*, an outstanding historical biography of the Middle Ages. Einhard married Emma, sister of Bernhard, Bishop of Worms. He died at Main, Germany, Mar. 14, 840.

EINHORN, DAVID (1809-79), rabbi and scholar, was born in Bavaria, Nov. 10, 1809. He was educated in German universities and soon became a leader of the reform wing of Judaism. His radical views made his rabbinical career in Germany a hectic one. In 1852 he ministered to a Jewish congregation in Budapest, Austria-Hungary. While in Germany, he was a leading figure in a series of rabbinical conferences.

In 1855 Einhorn received a call to Baltimore, where he became rabbi of a Reform congregation. There he published a Reform prayer-book, which has become the basis of the Union prayer-book, used in nearly all the Jewish Reform congregations of the United States. He became a vehement opponent of slavery, particularly in his German monthly *Sinai*, and was compelled to flee for his life at the time of

the Baltimore riots of Apr. 1861. Later that year, he was elected rabbi of a Reform congregation in Philadelphia, which position he held until 1866, when he was called to a New York liberal congregation. Einhorn retired from the ministry in July 1879. His American patriotism led to his election as an honorary member of the Union League Club of Philadelphia. He was a distinguished orator and scholar, and unswerving and self-sacrificing in the exposition of his convictions. A selection of his German sermons was edited by Dr. K. Kohler in 1881 and reprinted in the *Einhorn Memorial Volume* in connection with the commemoration of the 100th anniversary of his birth. Einhorn died in New York, Nov. 2, 1879. M. J. K.

See K. Kohler and E. G. Hirsch, sketches in the *Einhorn Memorial Volume*, 1911.

EINSTEIN, ALBERT (1879-), Swiss-German scientist, was born in Ulm, Württemberg May 14, 1879, of Jewish parentage. His youth was spent in Munich. While a student at the University of Zürich, he supported himself by teaching in the technical high school of that city. After teaching at Schaffhausen during 1900-01, he accepted a position in the government patent office at Berne, having become a naturalized Swiss. Here it was that he carried on his studies that led to the doctorate at the University of Zürich. In his notable thesis of 1905 he first expounded the theory of RELATIVITY. The famous Michelson-Morley experiment had aroused his interest, and it was from this experiment that he originally took his cue. First enunciated as a special theory of relativity, Einstein generalized it in 1915 by applying it to the field of gravitation, publishing his work, *Relativity*, in 1920.

After the publication of his dissertation, his work was soon recognized. In 1909 he was called to the University of Zürich as a professor of theoretical physics, in 1911 to Prague and in 1912 again to Zürich, this time to the polytechnic school. In 1913, he was invited to deliver an address before the Prussian Academy of Science, which led the following year to his appointment as director of Kaiser Wilhelm Physical Institute at the University of Berlin. In 1921, he was the recipient of the Nobel Prize for physics and was elected a member of the Royal Society. He was awarded the Copley medal of the Royal Society in 1925 and the gold medal of the Royal Astronomical Society in the following year. In 1929, he presented papers on the UNIFIED FIELD THEORY, in which gravitation and electricity were treated under common formulae, and published *Zur Einheitlichen Feldtheorie*. In 1931, he announced the success of a new unified field theory which supplanted the one of 1929. In 1930, he published the work *About Zionism*. In Dec. 1930, he came to America where, at Mount Wilson Observatory and the California Institute of Technology, he pursued his scientific investigations. Observations made at that time caused him to abandon his conception of a spherical space. He returned to Europe in March and was Rhodes Memorial Lecturer at Oxford in 1931,

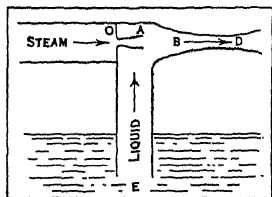
being elected to a research professorship at Christ's Church in October. In Dec. 1931, Einstein returned to America to continue his work in California.

Einstein has done important scientific work other than that connected with astronomy. He was the first to develop a complete theory and formulae for the complex BROWNIAN MOVEMENTS which had puzzled scientists for almost a century. In papers presented between 1905 and 1911, he developed the QUANTUM THEORY and the Law of Photo-electric Effect. He also investigated Planck's Law and developed a Law of Radiation.

EISENACH, a German city, located in Thuringia at the junction of the Hesse and Hörsel rivers. Until 1918 it was the second residence of the grand dukes of Saxe-Weimar-Eisenach. The western and southern sections of the city are residential in character. Of the seven cloisters, one is left, now a school and museum. Noteworthy is St. Nicholas' Church, 12th century. In other sections of the city, automotive vehicles, bicycles, machinery, electric appliances and spun goods are made. The Wartburg, a castle, built in 1067 on a mountain overlooking Eisenach, was the home of the early German poetry and the legendary Singers' War. MARTIN LUTHER spent nearly a year, 1521-22, in the castle and translated the Bible there. The city is the birthplace of BACH, his home now being a museum. Pop. 1925, 43,385.

EJECTMENT, a form of action at law for trying the title to land. Originally it was an action by a lessee against one who had ejected him from the leased property. The judgment is for possession only. In some states it is an action to recover immediate possession of real property. In many states it is superseded by an action for the recovery of real property, to which, however, many incidents of the old action still attach.

EJECTOR, a mechanism which utilizes steam or compressed air to remove liquids and loose materials, as sand and cinders, from a container. In its operation, steam passes through the orifice, O, (see figure) whence its velocity increases, then through the flaring tube, A, into the chamber, B, and on through the nozzle, D. This action creates a vacuum in B and



the liquid, E, is forced into B by atmospheric pressure. There it is caught by the steam and carried through D in a continuous stream.

EKATERINODAR. See KRASNODAR.

EKATERINOSLAV. See DNEPROPETROVSK.

EKELUND, VILHELM (1880-), Swedish poet and essayist, was born in Scania, Oct. 14, 1880. Among his collections of poems are *Murmurs of Spring*, *Visions* and *Dithyrambs at Evenglow*. They are nature poems and are almost invariably reflective and symbolic. His prose works, some of which might well be called prose poems, include *The Ideal of An-*

tiquity, *Books and Travels*, *Bows and Lyres* and *Attic Thought in Bird's-Eye View*.

ELAGABALUS, MARCUS AURELIUS (c. 205-222 A.D.) Roman Emperor, born at Emesa in Syria, and originally named Varius Avitus Bassianus. As a boy he was a high-priest of Elagabalus, the Syrian Sun-god, from whom he later took his name. Related to the imperial family of the Severi, he succeeded CARACALLA, being saluted as emperor by the Roman legions in Syria. After his arrival in Rome he appointed his cousin ALEXANDER SEVERUS as a colleague. Repenting this act, Elagabalus tried to have Alexander Severus put to death. But the praetorians, well-disposed to Alexander, slew Elagabalus. His eastern superstitions and extravagance made Elagabalus uncongenial to the Romans.

ELAMITIC, an extinct language, also called Anzanite, Susian, etc., preserved in a large number of inscriptions from the areas of Luristan and Khuzistan in Persia. The texts are written either in quasi-hieroglyphic (see HIEROGLYPHS) or CUNEIFORM characters, and are frequently accompanied by parallel versions in ACCADIAN or Old PERSIAN which have made it possible to gain a very fair knowledge of the structure of the language. Elamitic is known from about 2600 to about 336 B.C. and appears in the two closely similar stages of "Old" and "New Elamitic." It shows evidence of strong stress ACCENT, lack of grammatical gender, indication of CASE either by mere position or by postpositions, and a transitive and intransitive verb, the latter apparently serving also as a passive. Its linguistic affinities are unknown, though it would seem to be connected with MITTANIAN and KHARRIAN.

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ELAND, an African antelope (*Taurotragus oryx*), once abundant in South and East Africa. This, the largest of all antelopes, stands 6 ft. in height, and may weigh 1,500 lbs.; the strong, straight, twisted horns present in both sexes may be 28 in. long. The eland's form is ox-like, enhanced by a great dewlap and long tail, and the coat is uniformly bright fawn in color, becoming gray when old. The ease with which this heavy and comparatively slow animal might be killed by lions, by the natives for food, and by white men for sport or for the valuable hide, added to the plague of rinderpest, which devastated the cattle and game of Africa about 1890-95, have brought this fine animal near to extinction. It breeds well in captivity, and efforts are in progress to develop the eland into a valuable domestic animal.

ELASTICITY. Solid bodies offer resistance to a change in form or size. When they are distorted they tend to recover their original form or size. Bodies which exhibit this property of recovery to a large degree are called elastic bodies. Thus, a steel ball is more elastic than a rubber one, and yet we always think of rubber as being elastic. The internal forces which tend to restore the shape of a body come from the attractions which the molecules have for one an-

other (*see* COHESION). The distorting force is commonly referred to as the *stress*, and the resulting distortion is called the *strain*. Hooke found that, within limits, the ratio.

$$\frac{\text{stress}}{\text{strain}} = \text{constant.}$$

This law has been applied to the various types of elasticity and found to be a very useful law.

Stretch Modulus. When Hooke's Law is applied to the stretching of a wire or rod, it is known as Young's Modulus. The stress is the force of the elongation per unit cross-section, and the strain is defined as the elongation per unit length. Substituting these expressions in the formula given by Hooke, we get,

$$Y = \frac{\text{stress}}{\text{strain}} = \frac{F/a}{el} = \frac{Fl}{ae}$$

where Y is Young's Modulus, F the force applied, l the length of wire stretched or compressed, a the area of cross-section and e the elongation or compression for the force, F . Within limits, this holds surprisingly well. Y is a very large number and is the force necessary to stretch a unit cube of the substance through a unit distance.

If a wire or rod is stretched too far, it passes a point called the *true elastic limit*. Once the specimen passes this point, it no longer will return to its original form or size. Increasing the stress still further, the rod or wire passes the *yield point* and suffers permanent distortion. The value of the stress at which it begins to decrease, although the distortion is still increasing, is called the *tensile strength* of the material. It is the maximum load which the material will carry for that particular size and shape.

Twist Modulus. This is usually called the modulus of rigidity or coefficient of rigidity. It is a measure of the relation between the stress and strain involved in twisting a wire or rod. The modulus of rigidity is a measure of the resistance of a substance to having one layer of molecules sheared past the other, as for instance, in sliding the leaves of a book over each other. The coefficient, or modulus, of rigidity is defined as the ratio of the shearing stress to the shearing strain and is an application of Hooke's Law to the elastic properties involved in twisting a body. It is expressed by the equation

$$n = \frac{\text{shearing stress}}{\text{shearing strain}} = \frac{2Tl}{\phi\pi R^4}$$

where n is the coefficient of rigidity, T the torque applied in twisting a rod of length l and radius R , and ϕ is the angle through which the rod is twisted.

There is an elastic limit here as well as in the stretch modulus, and there is also a point where the torque applied begins to decrease, although the twisting continues just as it did in the preceding modulus.

Bulk Modulus. If a hydrostatic pressure is applied to a body, i.e., a uniform pressure normal to every part of the surface of the body, it will change its volume. The ratio of the force per unit area, or stress, to the change in volume per unit of volume, or

strain, is defined as the bulk modulus. It is expressed by the equation

$$B = \frac{\text{Hydrostatic stress}}{\text{Hydrostatic strain}} = \frac{p}{v/V} = \frac{pV}{v}$$

where B is the bulk modulus, p the pressure, or force, per unit area applied to the body and v the change in the volume of the total volume V . The reciprocal of B is called the *coefficient of compressibility*.

All of these moduli are very important in the field of structural design. The carrying load of the huge cables used in building suspension bridges may be studied from a single strand of the wire used in their construction, before the cables are put in place. Their stretch modulus, elastic limit and tensile strength must be very accurately known in order to determine what load may be carried. The coefficients of rigidity teach us what torques may, with safety, be applied to propeller shafting or to line shafting. The bulk modulus demonstrates also the structural qualities of the materials investigated. S. R. W.

ELASTICITY OF DEMAND implies a greater sensitivity of purchasers to price changes than an inelastic demand. Generally speaking, the demand for necessities is less elastic than that for comforts and luxuries. But the whole is a matter of degree. All demand is elastic. Other things being equal, an increase in price is met by diminished demand, and a decrease in price calls forth an ampler demand. Unitary elasticity defines a condition of demand under which at different prices the money income of sellers will be the same. An important factor contributing to elasticity of demand is the ease or difficulty with which the consumer may secure substitutes. If butter goes up in price, demand for it will fall off in favor of margarine. An increase in the price of salt, on the contrary, will not mean diminished demand, partly because there is no substitute for salt. The "accept no substitute" slogan of advertisers attempts to render demand inelastic at the usual price and at higher prices, and has the effect, the next most desirable consequence from the standpoint of sellers, of rendering the demand elastic at prices less than the normal. Largely because of inequality in purchasing power, demand is more elastic at high than at low prices. Agricultural staples particularly suffer from the fact that where there is a bumper crop demand does not increase commensurately with lowered price. This is partly due to perishability. Elasticity of demand varies in accordance with price ranges: for example, demand for anthracite coal will not increase or decrease with moderate departure from customary price, but if the price should be strikingly higher or lower, elasticity of demand would appear. *See also* SUPPLY AND DEMAND. B. M.

ELASTIC LIMIT. *See* STRENGTH OF MATERIALS. **ELBA**, an island of the Mediterranean, lying 7 mi. west of the mainland of Italy and forming part of Italy's province of LEGHORN. The island is about 20 mi. long and from 6 to 10 mi. wide, comprising an area of about 85 sq. mi. In ancient times it was noted for its iron mines, which are still being worked.

The vine is extensively cultivated, otherwise agriculture is neglected, the inhabitants being engaged mainly in fishing and mining. In 1802 the island, then belonging to Naples, was ceded to France. Elba was designated as the residence of Napoleon upon his abdication as emperor in April, 1814. He lived there for nearly a year. After his escape and final defeat in 1815 Elba was annexed by Tuscany. It became part of United Italy in 1860. Pop. 1931, 35,000.

ELBASAN or **ELBAZAN**, a town in central ALBANIA lying in a fertile valley and surrounded by beautiful olive groves and clusters of cypresses and fruit trees. It is on the highway from Koritza to Tirana. Before 1912 Elbasan was the seat of a sanjak included in the Turkish vilayet of Monastir. During the Balkan War the Serbians took it from the Turks, but in 1913, upon the formation of the Albanian state, it was ceded to that country. Elbasan has a plentiful water supply and a good climate. Although linens, pottery and tinware are seen piled high in its bazaar, the chief trade of the town is in the excellent olives grown nearby. Pop. 1930, 13,796.

ELBE, one of the principal rivers of Germany, rises in the Giant Mountains of Bohemia at an elevation of some 4,600 ft. It flows southward, but after leaving Czechoslovakian territory the river follows a general northwestern direction through Saxony and Prussia. After a course of 725 mi. it enters the North Sea near the port of Cuxhaven. The width of the Elbe at its mouth is about 14 mi. The principal tributaries are the Moldau, Eger, Saale, Havel and the Mulde. The most important cities situated on its banks are Hamburg, Dresden, Magdeburg, Wittenberg and Torgau. Ocean vessels can ascend as far as Hamburg but for small craft the Elbe is navigable to Melnik, Czechoslovakia, about 500 mi. from its mouth. Through a system of canals the Elbe is connected with the other principal rivers of Germany.

ELBERFELD. See WUPPERTAL.

ELBERT, MOUNT, the highest peak in Colorado, contained in the Sawatch range, a division of the Rocky Mountains. This summit occurs just east of the Continental Divide in Lake Co. and attains an altitude of 14,420 ft. above sea level. It has a magnificent eastern front cut by many cirques from which great glaciers once flowed into the valley of the Arkansas River. Its height is not outstanding since there are 46 mountain peaks in Colorado exceeding 14,000 ft. in height.

ELBING, second largest city in East Prussia, on the Elbing River, about 34 mi. southeast of Danzig. The metal industry is preeminent. Torpedo boats, locomotives and turbines are made. There are also large cigar factories; and trade in food products, cattle and lumber is active. Elbing was settled in 1237 by merchants of Lubeck and Bremen in conjunction with Hermann Balk, grand master of the Teutonic Order, and passed through the hands of Polish, Swedish, Russian and Prussian rulers. Pop. 1925, 67,878.

ELBOW-JOINT, the hinge-joint between the humerus or arm-bone and the radius and ulna of the

forearm. Movement is in only one plane, and backward motion is prevented by the engagement of the ulna upon the back of the humerus in extreme extension.

Both backward and forward dislocations of the elbow-joint occur. Dislocations at the elbow-joint are the most frequent of all dislocations in children. There is a bursa or sac containing fluid, which lies over the elbow. This sometimes becomes inflamed, and is known as miner's elbow.

ELBURZ, a mountain range of Persia, extending for 450 mi. along the southern border of the Caspian Sea, culminating in the volcanic Demavend (18,600 ft.), the highest peak. This giant of the Elburz range towers to a height of nearly 9,000 ft., above the sedimentary rocks (lias and jurassic lime and sandstone) of the adjoining parallel chains. The crater is of elliptical form about 4,500 ft. across and, if not quite extinct, quiescent and reduced to the condition of a solfatara.

On the northern slopes of the Elburz are large tracts covered with dense plantations of splendid timber, especially cedars, elms, oaks, the walnut, beech and the valuable box tree. Wheat and barley are cultivated to a height of several thousand feet.

ELBURZ, MOUNT, the loftiest of the Caucasus Mountains between 43° 21' N. lat. and 42° 25' E. long. It is situated on the northern or European slope of the principal range, and can be seen from a distance of over 200 mi. Elburz is a volcanic mountain, now extinct, with two summits, the lower rising to a height of 18,460 ft. and the higher, to 18,526 ft. At its base is a glacier from which flows the Kuban River. The snow-line is usually found at 10,700 ft.

EL CANEY, BATTLE OF, July 1, 1898, an attack in the SPANISH-AMERICAN WAR, correlative with the BATTLE OF SAN JUAN HILL. Gen. Lawton, with 4,500 men, attacked the fortified eminence of El Caney as part of the program for the advance of the American army upon Santiago. The Spanish force, only 520 men, under Gen. Vara del Rey, displayed unexpected resistance, maintaining the battle for several hours until a final assault by storm carried the position. The Spanish casualties numbered 400; the remaining 120 were taken prisoners. The American loss was 81 killed and 360 wounded.

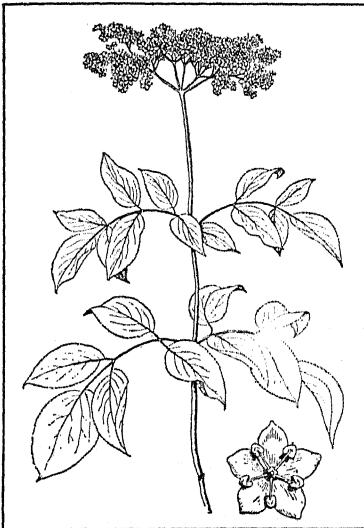
EL CENTRO, a city in southern California, the county seat of Imperial Co., situated in the central part of the Imperial Valley, near the Mexican border and 125 mi. east of San Diego. Several bus lines and two railroads afford transportation. There is a well-equipped airport. El Centro is situated below sea level, in the region originally desert but now well irrigated and highly productive. The countryside produces chiefly cotton, vegetables, especially lettuce, and cantaloupes and alfalfa. Certain crops are harvested every month. Dairying and stock-raising are also important interests.

El Centro was founded in 1905 and incorporated in 1907. It is the seat of a junior college. Imperial Valley, once the sea-bottom, has many points of geo-

logical interest. Northwest of El Centro is Salton Sea, noted for its mud geysers. Painted Canyon, a petrified forest and other natural phenomena peculiar to desert county are easily accessible. Pop. 1920, 5,464; 1930, 8,434.

ELDER, a functionary in various Protestant churches, with the same meaning as **PRESBYTER**. Among the non-Calvinistic churches the Baptist elder is an evangelist or missionary; the Methodist elder is a clergyman appointed by the bishop to the supervision of a district, and traveling elders are appointed to local charges, appointments being regularly made at the meeting of the conference. Mormons also have a grade of elders.

ELDER, the common name of a genus (*Sambucus*) of the honeysuckle family, comprising about 20 species found in the temperate and subtropical regions. They are usually shrubs or small trees, sometimes planted for ornament, with pithy stems, divided leaves, numerous flowers in dense showy clusters and small berry-like, often edible, juicy fruits. Among



FROM JEPSON, MAN. FL. PLANTS CALIF.. COPYRIGHT

BLUE-BERRIED ELDER

Flowering branchlet and single flower

the North American species are the common elder (*S. canadensis*), native to the eastern states and Canada; the red-berried elder (*S. racemosa*), native to Europe and Asia and found widely in North America, and the blue-berried elder (*S. glauca*) of the Pacific states. Where abundant the fruit of the common elder, used for pies, jams, and sauces, is sparingly marketed.

EL DORADO, a legendary region, pictured always as abounding in gold and precious stones of enormous size, and supposed to be situated in South America, presumably between the Amazon and the Orinoco rivers. Of the numerous expeditions which were bent on discovering El Dorado, the following may be noted: that of Diego de Ordaz, 1531, whose lieutenant, Martinez, located the region in Omoa; that of Orellano, 1540; and the expedition of Sir WALTER

RALEIGH, who placed El Dorado in "Parima" Lake, Guiana.

EL DORADO, a city and the county seat of Union Co. in southern Arkansas, situated near the Ouachita River, about 135 mi. south of Little Rock. Two railroads, bus and truck lines serve the city. The district produces cotton and Irish and sweet potatoes and has natural gas and oil wells. The chief industry of the city is oil refining; the retail trade in 1929 amounted to \$13,044,069. El Dorado was founded in 1843 and was incorporated in 1870. Pop. 1920, 3,887; 1930, 16,421.

EL DORADO, a city in southeastern Kansas, the county seat of Butler Co., situated on Walnut River, 35 mi. northeast of Wichita. Two railroads, bus and truck lines and an airport serve the city. El Dorado is surrounded by beautiful pasture land and is a shipping center for oil, grain and cattle produced in the vicinity. The city also has oil refineries and there are gas fields in the vicinity. In 1929 the manufactures reached about \$400,000; the retail trade amounted to \$7,669,785. El Dorado was the early home of William Allen White. Pop. 1920, 10,995; 1930, 10,311.

ELEATIC SCHOOL, the pre-Socratic school of philosophy emphasizing the permanence of things and denying the existence of change. Its best representatives were **PARMENIDES** and **ZENO**, while its leading opponent was found in **Heraclitus**. Parmenides argued for the immutability of being by showing that becoming is impossible, and Zeno strengthened his arguments by the famous paradoxes of motion.

ELECAMPANE (*Inula Helenium*), a rough-hairy perennial of the composite family, often cultivated in flower gardens. It is native to Europe and northern Asia and widely naturalized in eastern North America. The stout stem, rising 3 to 6 ft. high from a thick, branching, mucilaginous root, bears large long-stalked basal leaves, smaller clasping stem leaves and conspicuous yellow flower-heads. The roots, formerly highly prized in medicine, are now of limited use.

ELECTORAL SYSTEMS, primarily distinguished as "indirect" or "direct." In indirect election the office is filled by the choice of some type of "electoral college," as is legally, though not actually, the case with the President and Vice-President of the United States; the President of the French Republic by the National Assembly; of French senators by departmental electoral colleges; and of United States senators by state Legislatures until 1913. In direct elections the popular vote is cast directly for competing candidates; President of the German Reich; members of the United States Congress; American governors and hosts of lesser officers.

ELECTORS, anyone having the legal right to participate in the choice of a person to fill an office. In the Holy Roman Empire, a prince entitled to vote for election of the emperor. By the Golden Bull of 1356 the number was fixed at seven. Under the Constitution of the United States the President and Vice-

President are legally chosen by electors, appointed in each state as the Legislature may direct in number equal to the state's representation in Congress. *See also* ELECTORAL SYSTEMS.

ELECTORS, PRESIDENTIAL. The constitution of the United States established an indirect method of choosing the President and Vice-President. Each state appoints, in whatever way the legislature may direct, electors equal in number to its senators and representatives in Congress. Actually the electors are everywhere chosen by statewide popular vote in November of every fourth year; and, having been nominated by a particular party, they are morally bound to vote for its candidates. They meet in their respective states on the first Wednesday in January and ballot for President and Vice-President. The certified returns are counted in the presence of both houses of Congress on the second Wednesday in February, this procedure being regulated by a detailed statute of 1887. Since the electors exercise no discretion, the outcome of the presidential election is usually settled in November. But if no candidate receives a clear majority of the electoral vote, then the House of Representatives chooses the President and the Senate chooses the Vice-President. E. M. S.

ELECTRA, in Greek legend, the daughter of Agamemnon and Clytemnestra and the sister of Orestes and Iphigenia. Her noble courage, which saved Orestes from death and enabled him to avenge the murder of Agamemnon, is the subject of dramas by Aeschylus, Sophocles, Euripides, Racine and Goethe.

ELECTRA, a city in Wichita Co. in northwestern Texas, situated 27 mi. west of Wichita Falls. Bus and truck lines and the Fort Worth and Denver City Railroad serve the city. Cotton is the chief crop of the vicinity. Oil is produced, and oil-refining is the chief industry. The city was incorporated in 1917. Pop. 1920, 4,744; 1930, 6,712.

ELECTRICAL ENGINEER, one skilled particularly in the practical application of the physical knowledge of electricity and magnetism to industrial problems. His work is found in research, teaching, design, construction, application, operation, manufacturing, management and sales and may be performed in such technical divisions as power supply, communication, transportation, illumination, and the many industrial uses of electricity, or in business.

The calculations of the electrical engineer usually can be based on exact theory although his work is facilitated in many cases by the use of design information which has become standardized and the basic theory of which may not be considered in each production.

Electrical engineering demands a broad education, natural aptitude for applied science, high mathematical and analytical ability, the ability to speak and write clearly and forcibly and effectiveness in organizing human efforts. The education of an electrical engineer should therefore include not only the fundamentals of electrical engineering itself but also such general subjects as English, economics, biology, his-

tory, psychology, chemistry, mathematics, and general engineering subjects. This education must be supplemented by practical training. H. H. H.

ELECTRICAL EXPLORATION. *See* EXPLORATION, ELECTRICAL; GEOPHYSICS.

ELECTRICAL INSTRUMENTS. Many types of instruments are available for the measurement of ELECTRICITY and the study of electrical apparatus and circuits. The most frequently used of these are the indicating instruments, VOLTMETERS, AMMETERS, WATTMETERS, and FREQUENCY meters. They are designed for either temporary or permanent connection to the circuit, and when so connected, indicate directly, on calibrated scales, the values of the electric quantities which they are designed to measure. Such instruments are built in a wide range of sizes, varying all the way from the delicate THERMOCOUPLE instruments used to measure vacuum tube currents to the instruments which measure the entire output, running up to thousands of horse-power, of modern electric generators.

GALVANOMETERS and ELECTROMETERS are of more limited application: the former are used principally in the laboratory and in certain kinds of routine testing such as RESISTANCE MEASUREMENT. The use of electrometers is confined almost entirely to laboratory work. In the laboratory, galvanometers are used extensively in conjunction with various standards as a means of calibrating ordinary indicating instruments. Besides its use in general laboratory work, the galvanometer is one of the most important instruments for research purposes.

The OSCILLOGRAPH was originally developed as a laboratory device for the investigation of rapidly varying currents and voltages. Improvements in design and construction have made it rugged and portable, and its use in field tests and industrial investigation is now extensive. A type of oscillograph known as the string galvanometer is widely used in medical investigations, particularly with respect to heart action; the apparatus in which it is employed is called the *electrocardiograph*.

Special types of instruments have been developed for certain industrial purposes. The PHASE METER, for example, is a device used in the electric power industry for the measurement of POWER FACTOR. Curve-drawing, or recording, instruments have been developed for many industrial and laboratory requirements. Some of these are adaptations of standard instruments such as voltmeters, ammeters and wattmeters; others incorporate bridge circuits (*see* WHEATSTONE BRIDGE) and are controlled by galvanometers.

Used in conjunction with sensitive instrument movements of conventional design, the vacuum thermocouple provides the principal instrument by which direct measurements of high frequency currents and voltages are accomplished. Such measurements are of special importance in the field of electric communications and in the study of vacuum tube phenomena. At lower frequencies, very sensitive indicating instruments are built with crystal-type RECTIFIER elements

included as part of the instruments. By this means, a unidirectional current is obtained in the coil of the instrument and the permanent-magnet movement, which is more sensitive, can be used. Some instruments have also been built with vacuum tubes (*see* TUBES, ELECTRONIC) as rectifier elements. However, where measurements requiring this type of instrument are to be made, it is usually more satisfactory to use standard instruments with separate vacuum tube circuits. *See also* UNITS, ELECTRICAL. W. H. T.

ELECTRICAL RESONANCE. *See* RESONANCE, ELECTRICAL.

ELECTRICAL TRANSMISSION. *See* POWER TRANSMISSION, ELECTRICAL; SUPERPOWER.

ELECTRICAL UNITS. The system of units commonly used in the electrical industry is known as the practical system. It is based upon Act of Congress (July 12, 1894) which defines in a measurable manner the unit values of resistance, current and electromotive force, and also relates the definitions to unit values of the same quantities in the centimeter-gram-second electromagnetic system of units (*see* UNITS, PHYSICAL).

The unit of RESISTANCE, known as the ohm, is defined as the resistance at 0° C. of a column of mercury 106.3 cm. long and weighing 14.4521 grams. The unit of current (*see* ELECTRICITY) is the ampere, defined as the amount of current which, when passed through a standard solution of silver nitrate, deposits silver at the rate of 0.001118 gram per sec. The unit of electromotive force is the volt, defined as the 1/1.0183 part of the potential difference at 20° C. of the Weston standard cell.

Other units may readily be defined in terms of the three given above. One *coulomb* is the quantity of electricity conducted through a circuit when one ampere flows for one second. One *joule* is the amount of energy expended in one second by a current of one ampere flowing in a resistance of one ohm. One *watt* is the power equivalent to expending energy at the rate of one joule per second. Note that power in watts is given by the product of electromotive force in volts and current in amperes. One *henry* is the INDUCTANCE of a circuit in which a current changing at the rate of one ampere per second induces an electromotive force of one volt. One *farad* is the CAPACITANCE of a condenser which is charged to a potential of one volt by one coulomb of electricity.

The practical system of electrical units is related to the fundamental centimeter-gram-second units of length, mass and time through the c.g.s. electromagnetic and electrostatic systems of units. The prefix "ab-" is used for distinguishing electromagnetic units, e.m.u., and "stat-" for electrostatic units, e.s.u. Thus, the unit of current is the *abampere* in the former, and the *stat-ampere* in the latter. The conversion factors between practical and electromagnetic units are multiples of ten, as, e.g., one abampere equals 10 amperes. The conversion factors between practical and electrostatic units are not even multiples of ten, but involve also the numerical value of the velocity of light, 3×10^{10} cm. per sec.

A list of some of the important conversion factors is given below. It should be noted that this list shows the relative sizes of the units, and in converting from one system to another the numerical value of the quantity becomes smaller if the size of the unit increases, and vice versa.

Practical	e.m.u.	e.s.u.
1 ohm =	10^9 abohms	$= 1/9 \times 10^{11}$ statohm
1 volt =	10^8 abvolts	$= 1/300$ statvolt
1 ampere =	$1/10$ abampere	$= 3 \times 10^9$ statamperes
1 coulomb =	$1/10$ abcoulomb	$= 3 \times 10^9$ statcoulombs
1 henry =	10^9 abhenries	$= 1/9 \times 10^{11}$ stathenries

See also MAGNETIC UNITS.

W. H. T.

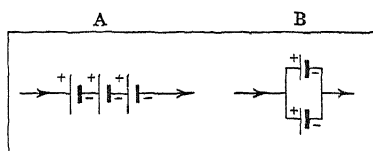
ELECTRIC APPARATUS AND APPLICATIONS may be divided into three groups as follows: I. Those for the generation of electromotive forces and for the control of the electric currents produced by them. This group includes: The various forms of direct and alternating-current generators (*see* ELECTRIC GENERATOR) and the various required accessories, such as TRANSFORMERS, SYNCHRONOUS CONDENSERS and LIGHTNING ARRESTORS; the voltaic CELL, including both the primary and the storage cells (*see* ELECTRIC BATTERIES); ELECTROSTATIC MACHINES for the production of high differences of potential between charges at rest; the THERMOCOUPLE, in which heat energy is transformed directly into electricity.

II. Those for the measurement of the various electrical quantities (*see* ELECTRICAL INSTRUMENTS). This group includes: Voltmeters, potentiometers and electrometers for the measurement of electromotive force and difference of potential, both direct and alternating; GALVANOMETERS, AMMETERS and voltmeters for the measurement of the electric current; WATTMETERS and watt-hour meters for the measurement of power and energy; resistance boxes, standard CONDENSERS, standard INDUCTION COILS and magnetic standards for the measurement, respectively, of RESISTANCE, CAPACITANCE, INDUCTANCE, and magnetic flux.

III. Those for applying electricity to some useful purpose, which include: Motors (*see* MOTOR, ELECTRIC) for the transformation of electric into mechanical power; heating devices, such as stoves, irons and furnaces for the melting of ores; instruments for the measurement or control of temperatures (*see* THERMOCOUPLE), used in nearly all industrial establishments; TELEGRAPH, TELEPHONE, RADIO COMMUNICATION and apparatus for the transmission of signatures, photographs and scenes (*see* TELEVISION; TELETYPESETTERS; TICKERS); miscellaneous appliances, such as those used in geophysical explorations, separation of metals, medical treatment, protection from lightning, BURGLAR ALARMS and research. *See* FIRE ALARMS; EXPLORATION, GEOPHYSICS. A. Z.

ELECTRIC BATTERIES, units consisting of two or more primary or STORAGE CELLS connected in series or in parallel and used together as though they were one cell; one cell does not comprise a battery. The cells are connected in *series* when the + plate of one cell is connected to the — plate of the other in succession, so that the whole current in the circuit must pass

through each of the cells. The electromotive force and the RESISTANCE of a battery composed of cells in series is the sum of the electromotive forces or of the resistances, as the case may be, of the individual cells.



BATTERY CONNECTIONS
(A) Cells in series; (B) cells in parallel

The cells are connected in *parallel* when the + plates of the separate cells are connected together so as to form what is virtually one plate, the — plates being similarly connected. Each cell, then, carries only a part of the current flowing through the circuit. In this case, the total electromotive force is that of one cell, while the resistance is that of one cell divided by the number of them in parallel. This arrangement is useful when the current is greater than the carrying capacity of one cell, or, if the cell resistance is large, to diminish the internal resistance of the battery.

A. Z.

ELECTRIC CABLES, stranded conductors, usually insulated, or combinations of insulated CONDUCTORS. Cables are insulated with RUBBER for low voltages; flexible, varnished-cambric cables may be used for potential up to 5000 volts. Impregnated-paper cables, used exclusively for high voltages, consist of paper tape wound spirally around the conductor and impregnated with resins and mineral oils. A lead sheath is necessary with such cables. For high voltage, three-phase circuits, three single-conductor cables are used; in the type H (Hochstadter) three-conductor cable, each conductor is insulated and surrounded by a perforated metallic covering.

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ELECTRIC CHARGE, a quantity of static electricity. A body is said to be charged when it attracts bits of paper or chaff, or repels other bodies in similar condition. Under the ELECTRON THEORY, any means of producing a charge of electricity is essentially a process of separating electrons from PROTONS. Under normal conditions, the number of electrons present in any ATOM is such that the positive and negative charges are equal in amount and completely neutralize each other. If, however, this equilibrium is disturbed by the removal, or by the addition, of one or more electrons, the atom is no longer neutral, but exhibits a positive or negative charge, according to the deficiency or the excess of electrons. Strictly, when an atom has lost or gained an electron, although its constituents remain the same and its mass and volume are practically unchanged, it has lost something of its true atomic character, since a true atom is neutral.

When the group of atoms which go to make up any body takes on or gives up electrons, the body is charged. Thus, when a dry glass rod is rubbed with silk, electrons, by some process not yet clearly under-

stood, are transferred from the glass to the silk, the silk thereby acquiring a negative charge and the glass rod a positive one. Hence, a negatively charged body is one possessing an excess of electrons; a positively charged body has a deficiency of electrons. Also, any charging process is a process of shifting or transferring electrons from one place, or body, to another. The electron is very small compared to an atom. It is conceivable, therefore, that electrons may move among the atoms of a solid body. The electrons are considered as moving in this manner in the process of charging by INDUCTION and in metallic conduction in general.

L. B. S.

ELECTRIC CONTACTORS. See CONTACTORS, ELECTRIC.

ELECTRIC CONTROLLERS, devices for regulating the operation of electric motors (see MOTORS, ELECTRIC) that drive conveyors, elevators, machine tools, rolling mills and the like. They will start, stop, reverse, brake the motor and control its speed. A common type is that used on electric railroads, which comprises a drum having contacts mounted upon it against which stationary fingers press. This connection completes a circuit which includes control of the motor resistance and the change over from series to parallel connection of the motors. By a series of interconnected RELAYS, control over the speed of many motors can be obtained from the same place—as on multiple-car trains on subway lines. Or in other applications the control of an inaccessible motor may be obtained from a convenient location. Controllers have been developed for many different applications and vary widely in design.

C. L. D.

ELECTRIC DISCHARGE, the escape of positive electricity from a higher to a lower potential level, analogous to water running down hill. According to the ELECTRON THEORY, the electric flow is in the opposite direction; i.e., the electron flow is from the region of lower to the region of higher potential.

There are different types of discharge, each producing characteristic effects. For example, in the gradual discharge of a storage BATTERY, the discharge circuit is heated and other effects typical of the electric current are produced for a relatively long period of time. In a LIGHTNING flash, a large quantity of atmospheric electricity is discharged in a very small fraction of a second producing heat, light, loud noise and various destructive effects where it strikes. By means of an ELECTROSTATIC MACHINE or an INDUCTION COIL, electric sparks may be produced, which, on a small scale, simulate lightning discharges in all of their aspects. Discharges of this character, called disruptive discharges, are characteristic of gases. In general, the characteristics of an electric discharge through a gaseous body differ widely according to the conditions. In a given case, the character of the discharge and the effects produced by it depend upon the nature of the gas, the nature of the ELECTRODES between which it takes place and the pressure of the gas through which it passes.

For studying electric discharge of this character use

is made of a vacuum tube (*see* TUBES, ELECTRONIC) made of glass with seal-in electrodes which may be connected to the terminals of an induction coil. By means of an air pump, the gas in the tube may be gradually pumped away and the pressure of the residual gas lowered to any desired value.

Most of the effects observed in discharge through gases may be explained on the basis of IONIZATION, a process by which neutral ATOMS or MOLECULES are broken into parts carrying free electric charges. Since IONS in motion constitute an electric current, it is evident that an ionized gas is capable of conducting electricity. In some cases, a very few ions will be sufficient to start the action of discharge, and the number of ions will be increased by the effect of the moving ions upon the neutral gas molecules among which they are traveling. The ions, in response to the intense electrostatic field, move rapidly and acquire so much kinetic energy that, when they collide with neutral gas molecules, they ionize them. The new ions start to move, and in turn produce others.

The velocity acquired by a moving ion depends largely upon the average distance traveled between collisions, which is determined by the pressure of the gas. Thus, the effects produced vary with the pressure. When the pressure is about one-thousandth of an atmosphere, a characteristic luminous column fills the discharge tube, the color being determined by the nature of the residual gas. This is known as the *Geissler Effect*. The now familiar Neon tubes are of this nature. At much lower pressure, of the order of about one-millionth of an atmosphere, the CATHODE RAYS, consisting of electrons streaming at enormous velocities in straight lines away from the CATHODE, constitute the more important part of the discharge. These electrons are believed to come from the cathode material, from which they are set free by the bombarding positive ions. The cathode rays, when intercepted by a suitable ANTICATHODE, produce X-RAYS.

L. B. S.

ELECTRIC FIELD, the space surrounding an electrically charged body (*see* ELECTRIC CHARGE). If the charges are in motion with respect to the observer there is also a magnetic field (*see* MAGNETISM). Charged bodies exert forces on one another through the intervening space (*see* ELECTRICITY). As all matter is formed of minute, electrically charged particles, ELECTRONS and PROTONS, these forces are everywhere in matter and govern even the structure of ATOMS and MOLECULES. The electric field is conveniently represented by imaginary lines of electric force having at each point the direction of the force that would act on a positive charge placed at that point. These lines of force all originate on positive charges and end on negative charges. The field is intense where the lines are dense, as where they diverge from a positive charge or converge on a negative one.

When the electric field is altered at one place, as when an electron in motion is brought to rest, the alteration does not occur instantly at all points in the field but spreads out in a wave from the point of first

disturbance. The velocity of this wave, predicted from the laws of ELECTROMAGNETISM, is the same as that of LIGHT.

R. T. C.

ELECTRIC FISH, the name given to various fishes possessing the power to inflict electric shocks with which to paralyze their prey and benumb their enemies. In general the electric organs appear to be developed from muscular substance, and their action, which is in the main voluntary, resembles muscular activity. Like a muscle, the electric organ soon becomes exhausted through use and must be restored to efficiency by a period of rest.

In the electric rays, large marine fishes often called torpedoes (*Torpedinidae*), the electric organs consist of large honeycomb-like structures filled with a jelly-like substance and are situated just back of the head. Two species occur in North American waters, the Atlantic torpedo or crampfish (*Tetranarce occidentalis*) found sparingly from Cape Cod to Cuba, usually weighing somewhat less than 30 lbs., but occasionally reaching 200 lbs.; and the California torpedo or crampfish (*T. californica*), also of large size, found from Monterey north to Washington. The Brazilian torpedo or small electric fish (*Narcine brasiliensis*) strays occasionally northward to Key West and the coast of North Carolina.

The electric catfish (*Malopterurus*), found in African rivers, has an electric organ which extends over the entire body. The electric eel (*Electrophorus electricus*), the most powerful of the electric fishes, has two pairs of shock organs, one on the tail and the other on the anal fin. This formidable fish is not a true eel, but an eel-like fresh-water fish, sometimes 6 ft. long, allied to the carps and suckers. It occurs in the rivers of Brazil and Guiana. *See also* RAY; TORPEDO RAY.

ELECTRIC FURNACE. Electrical energy may be converted into heat energy by: (a) resistors, (b) induction, (c) the electric arc.

Resistor furnaces are mostly used for temperatures under 1800° F., although silicon carbide, granular carbon, or molybdenum wire wound furnaces in hydrogen permit of much higher temperatures. Because of accuracy of control and uniformity of temperature distribution resistance furnaces are much used for heat treating of metals which include: annealing (*see* HEAT TREATING), NORMALIZING, hardening and drawing.

Induction furnaces utilize transformer action to induce currents to flow in the charge itself which produces heating by resistance; two types are recognized: low frequency and high frequency. They are used for melting metals.

Every known substance can be melted in the electric arc. Arc furnaces may be of the submerged type where the electrodes are buried in the charge such as in the preparation of calcium carbide and ferro-alloys.

Indirect arc furnaces radiate heat to the charge from an arc between electrodes. This type is used for non-ferrous metals and some iron, but is limited to comparatively small capacities.

The direct arc furnaces apply the arc directly to the charge by vertically placed electrodes. Most of the electric arc melting furnaces are of this type.

G. L. SL.

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ELECTRIC GENERATOR, a DYNAMO-ELECTRIC MACHINE for converting the mechanical energy of a prime mover into electrical energy. A generator may supply direct current, in which case a COMMUTATOR is necessary for rectifying the alternating currents induced in its ARMATURE windings, or it may supply alternating current. In the latter case, if the alternating current is single-phase, the machine is known as a single-phase alternator or single-phase generator, while, if multiple-phase current is supplied, the machine is a polyphase alternator or polyphase generator. Alternating current generators may be of the synchronous type, in which the frequency is equal to the product of the speed in revolutions per second and the number of pairs of poles, or they may be of the induction type, the frequency being less than the above product by a percentage termed the "slip," which decreases to nearly zero at no-load. Induction generators are excited by current from synchronous generators.

H. M. H.

ELECTRIC HEATING. See HEATING, ELECTRIC.

ELECTRICIAN, a person having a practical knowledge of electricity, particularly one who is skilled in the installation, maintenance and repair of electrical circuits and machinery. The electrician is a TECHNICIAN and works under the direction of or follows the plans drawn by an electrical ENGINEER. The usual work of an electrician is the installation or maintenance of the wiring in a building. A common school education, followed by work with experienced men, or a course in a trade school, is generally sufficient. For the position of chief electrician greater experience or more technical training is necessary.

ELECTRIC INSULATION. See INSULATION, ELECTRIC.

ELECTRIC INSULATORS. See INSULATORS, ELECTRIC.

ELECTRICITY. The most primitive observations in electricity concern a state in which bodies exercise attractions and repulsions on other bodies. This state is very readily produced in amber by rubbing it with a dry cloth. From the Greek name for amber, *elektron*, any body in this state is said to be electrified or charged with electricity. Many other substances, as glass, resin, sealing-wax and hard rubber, exhibit the same properties. If two pieces of resin are rubbed with two pieces of fur, it is observed that the two pieces of resin, being similarly electrified, repel one another, as do the two pieces of fur. On the other hand, between either piece of resin and either piece of fur an attraction is observed. This is explained by the recognition of two opposite kinds of electrification with the property that bodies similarly electrified repel one another, while those oppositely electrified attract one another. To signalize the opposite character of

the two charges, that which is found on the fur is called positive and that on the resin is called negative. With certain precautions taken to prevent the escape of the charges, it is found, generally, that when any two dissimilar substances are rubbed together, or otherwise brought into close contact and then separated, one is charged positively and the other negatively.

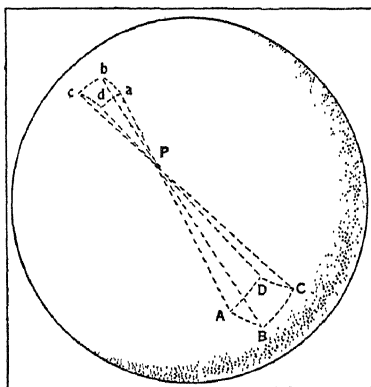
Electricity and Matter. The significance of the above phenomena is enhanced by the electronic theory of matter, now universally accepted. According to this theory, all matter is composed of two kinds of particles identical among themselves. The particle of one kind, the PROTON, carries a positive charge and acts as a NUCLEUS; that of the other kind, the ELECTRON, carries a negative charge and, in general, revolves about the proton. In any substance not electrified, protons and electrons are present in such numbers as to neutralize each other electrically. The electrons are the less massive and, hence, the more mobile particles, and it is a transfer of them which generally takes place in the electrification of a body. Moreover, electrical conducting substances have a large portion of free electrons. A negatively charged body is one which has more electrons than it would have in the uncharged state; a positively charged body has less. It is most probable that all physical and chemical forces except, perhaps, the force of gravitation, are either electric forces or the magnetic forces derived from them. There have been several attempts, notably that of EINSTEIN in his unified field theory, to relate electromagnetic and gravitational forces to a common source.

Charges. In certain substances, particularly the metals, it is found that a charge can not be localized in a chosen region of the body but is distributed over the entire surface. Such substances are called conductors of electricity (see ELECTRICITY, CONDUCTION OF). Certain other substances permit enough localization of charge to be called non-conductors or insulators. The difference is ascribed to the difference in mobility of electrons in the different substances except in the case of conducting solutions and gases, in which substances the mobile particles are largely charged atoms or groups of atoms.

It is found that with a closed shell, made of metal or other conducting material, no charge on the surface will produce any force on a charge inside. From this fact, applying rather simple geometrical reasoning to the case of a spherical shell, it may be shown that the electric force between two charged particles is inversely proportional to the square of the distance between them and directly proportional to the charge on either particle.

The figure represents a spherical shell. Through any point, *P*, within it, let four lines be drawn, intersecting the shell on one side at the corners of the small quadrilateral, *abcd*, and on the other side at the corners of a similar quadrilateral, *ABCD*. The ratio of the areas of the two quadrilaterals (in the limit as they are taken smaller and smaller) will be equal to the ratio of the squares of their distances from *P*. The

charge being uniformly distributed over the surface of the shell, the quantities of charge on the two quadrilaterals will be in this same ratio. If, then, the force exerted on a charge at *P* by the quantity of charge on



each quadrilateral be proportional directly to the quantity of charge and inversely to the square of its distance, the forces exerted by the two quantities will be exactly equal. Since the two forces are opposite in direction they will exactly balance one another. By dividing the entire spherical surface into such pairs of areas, it is seen that each pair of forces balances separately and so there is no resultant force on a charge at *P*, as is found experimentally to be the case. *See also* ELECTRIC CHARGE.

Electric Fields. Any region in which there exist sensible electric forces is called an **ELECTRIC FIELD**. A positive charge placed at any point in the field will be subject to a force in a definite direction, and this direction may be called the direction of the field at that point. If a conductor be placed in an electric field, there will be, according to convention, a flow of positive charge in the direction of the field. Actually, there will be a flow of the negatively charged electrons in the opposite direction. Such a flow is called an electric current. In the case just described, the current will persist only for an instant. When it ceases, charges will have accumulated on the surface of the conductor which exactly neutralize in its interior the electric field which caused the current. Charges so caused are called induced charges. *See also* ELECTRIC FIELD.

Current. There are various ways in which a current can be maintained steadily in a conductor. These methods are alike in that they all require a closed electric circuit, i.e., a closed conducting path around which the electrons can circulate continuously. Moreover, they all require an electromotive force, i.e., a supply of energy for the circulating charge. The essential difference among the several methods is in the nature of the energy which is transformed into electric energy in order to maintain this electromotive force. In a thermo-electric circuit (*see* THERMO-COUPLE), this energy is supplied in the form of heat; in the familiar dry cell and STORAGE CELL, it is chemical energy; in the electric generator (*see* DYNAMO ELECTRIC MACHINE) it is mechanical energy.

Conversely, there are transformations of electric energy into these several forms. There is a heating effect whenever a current passes through any conductor, the electric energy being transformed into thermal energy. This effect is the basis of all electric heating appliances, and also of all electric lamps in which a filament is heated to incandescence by the passage of an electric current. For a given conductor, the quantity of heat evolved in a given time increases with the current, being proportional to its square. For a given current, the heat evolved in a given time depends on the dimensions and material of the conductor, being proportional to that property of a conductor known as its **RESISTANCE**.

Conduction. The resistance of a conductor is proportional directly to its length and inversely to its cross-sectional area. That is, a long thin conductor offers more resistance to the flow of electric charge than a short thick one of the same material. The resistance increases, generally, with the temperature of the conductor. With certain metals, at extreme low temperatures the resistance drops to a value almost negligible, and a current started in the conductor will persist for days without any source of new energy. This phenomenon is called **superconductivity**. The resistance of a conductor depends also, of course, largely on the material of which the conductor is made. It is found that the metals with the lowest relative resistance are also those which conduct heat most readily. There is, in fact, a rough proportionality between the electrical and thermal conductivities of metals. According to the **ELECTRON THEORY**, the conduction of electricity is a flow of electrons along the conductor. The proportionality just mentioned indicates, then, that the electrons are also the agents in the conduction of heat in metals. The evolution of heat by an electric current is readily pictured in terms of the electron theory and of the **KINETIC THEORY** of heat. According to the latter theory, heat is a molecular agitation of bodies. Under the action of an electric field, the free electrons are accelerated, showing that they acquire energy from the electric field. At frequent intervals they collide with molecules in the conductor, dissipating their kinetic energy in agitating the molecules. Thus, electric energy is spent in evolving heat. For further discussion, *see* ELECTRICITY, CONDUCTION OF.

Electrolysis. The transformation of electrical energy into chemical energy occurs in the phenomenon of **ELECTROLYSIS**, whereby chemical constituents are separated out of solutions. The passage of an electric current through a solution involves an actual conveyance of matter, atoms, or groups of atoms, carrying the electronic charges through the liquid. Thus, when a current passes through water, to which a trace of acid is added to make it electrically conducting, oxygen is liberated at the place at which the current is said to enter, hydrogen being liberated at the opposite electrode. Also, a current passing between metal electrodes in a solution of copper sulphate will deposit copper on the electrode through which the current is

said to leave the solution. The same phenomenon occurs with all metals and supplies the usual means by which metal plating is applied.

Electric and Mechanical Energy. The transformation of energy between the electrical and mechanical forms is generally carried out by means of the magnetic effects of electric currents. A coil of wire carrying a current has the properties of a magnet. If suspended freely, it will take a definite position, as does a magnetic needle; it will attract iron and will magnetize a piece of iron placed close to it. A piece of iron magnetized by current flowing in a coil wound about it is called an **ELECTROMAGNET**. Electromagnets are used in a multitude of common appliances, notably in **TELEPHONES** and electric bells. An electric motor (*see* **MOTOR, ELECTRIC**), in its simplest form, consists of an electromagnet, called the **ARMATURE** or rotor, mounted on a shaft in the magnetic field of another electromagnet, called the stator. The electrical connections are so disposed that the force exerted on the armature by the magnetic field set up by the stator keeps the armature in continuous rotation. Machinery of any kind may be coupled to the shaft, and, thus, electrical energy is utilized to perform mechanical work. This transformation may be reversed; that is, the same machine may be used to transform mechanical energy into electrical. If a steam engine, internal-combustion engine or water wheel be coupled to the shaft so as to drive the rotor, thereby supplying mechanical energy, an electromotive force is induced in the coil wound on the armature. Thus, electrical power is produced, and a machine so used is called an **ELECTRIC GENERATOR**. By suitable connections, the armature of the generator may be connected in a **CIRCUIT** and so light lamps, charge batteries, drive motors, or supply electric power for any of the purposes for which it is used. Currents produced by the motion of a conductor in a magnetic field (*see* **MAGNETISM**), as in the generator, are called induced currents, and the phenomenon is called **electromagnetic INDUCTION**.

Transformation. It should be observed that the transformations of energy just described between the electrical and other forms are all subject to the general principle of the conservation of energy, in accordance with which, energy is neither created nor destroyed in physical processes but merely changed from one form to another. The energy obtained, for example, in the form of heat in an electric flat-iron must all be supplied elsewhere in the electric power system, e.g., in the form of heat produced by burning coal in a **POWER PLANT**. The advantage of using energy in the electrical form lies in the fact that it is readily converted, with simple, efficient apparatus, from this form into others; that it can be used when and where it is desired with reasonable economy in its transmission and conversion; and that its use does not produce refuse and other inconveniences, as do some other means of utilizing energy.

Electromagnetic Waves. An **ELECTRIC CHARGE**, as has been stated, exerts forces on other electrical

charges at a distance. If the charge moves suddenly, these forces are changed, but they are not changed instantly. On the contrary there is a time-lag which increases in magnitude with the distance from the moving charge. An oscillating charge as, e.g., a current reversing rapidly in direction, sends out vibrations or electromagnetic waves into the surrounding space (*see* **HERTZIAN WAVES**). Such are the waves used in **RADIO COMMUNICATION**. The velocity with which these waves travel is very great, but it is, nevertheless, measurable. It is found to be the same as the velocity of **LIGHT**, approximately 186,000 mi. per sec., and a comparison of the properties of light with those of electromagnetic waves leaves no doubt as to their identity. The difference between the electromagnetic waves of light and the electromagnetic waves used in radio communication lies in the **FREQUENCY** of the vibration, the frequency of the light waves being over a billion times that of wireless telegraphy waves. Among the electromagnetic waves of still higher frequency are **X-RAYS**, and **GAMMA RAYS** of radium and the penetrating, or cosmic, radiation (*see* **ALPHA RAYS**). *See also* **ELECTRIC WAVES**; **ELECTROMAGNETIC THEORY OF RADIATION**.

Electricity and Science. The development of the electromagnetic story of light and that of the electron theory of matter have altered the position of electricity in the structure of physical science. Before these developments, it was considered possible and desirable to explain electrical phenomena in terms of mechanical phenomena, which were assumed to be more fundamental. This aim has lately been in part reversed and in part diverted. The purpose of much recent research is to explain as many phenomena as possible in terms of electricity. In this point of view, which has produced valuable results, electricity is provisionally taken as fundamental. Beyond this point of view lie the researches in which the electric field is regarded as a part of the geometry of the world of relativity. *See also* **UNITS OF ELECTRICITY**; **ELECTRIC APPARATUS AND APPLIANCES**; **ELECTRIC MEASUREMENTS**; **ELECTRODYNAMICS**; **ELECTROSTATICS**; **ELECTROMAGNETISM**.

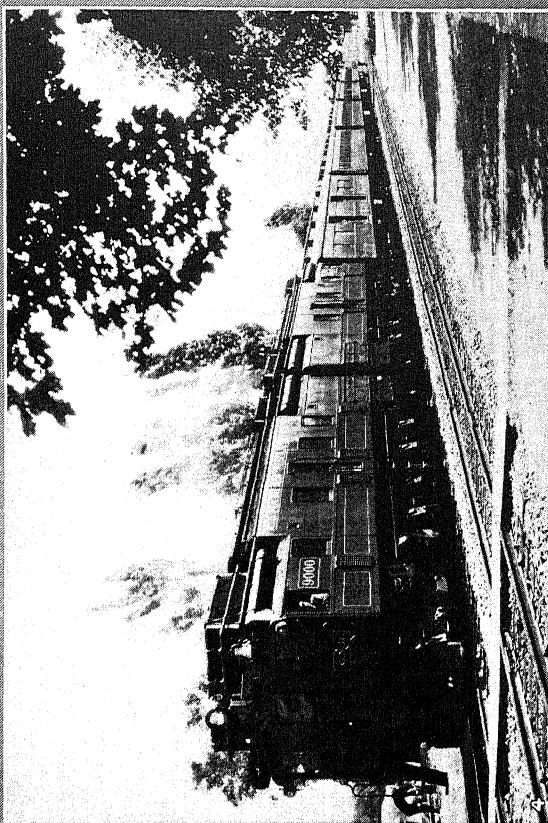
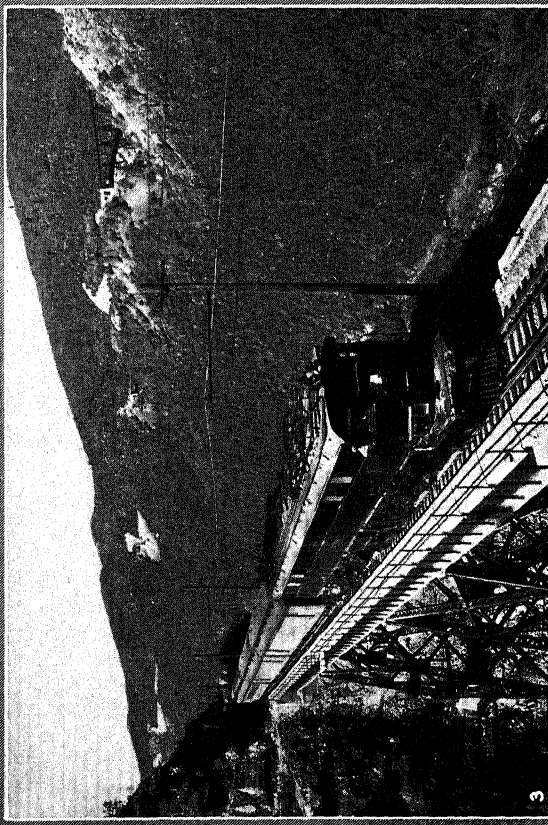
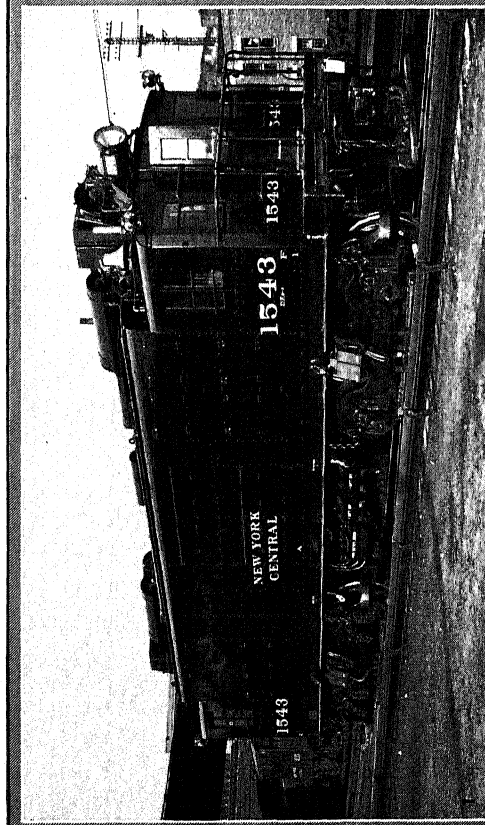
R. T. C.

ELECTRICITY, ATMOSPHERIC. *See* **ATMOSPHERIC ELECTRICITY**.

ELECTRICITY, CONDUCTION OF. Electricity may be conducted in a vacuum, in liquids, in solids and in gases. An example of conduction in vacuum is given by the vacuum tubes used in **RADIO COMMUNICATION**. In these tubes (*see* **TUBES, ELECTRONIC**) a heated filament emits **ELECTRONS**. A voltage applied between the filament and the plate impels the electrons to the plate. Thus, an electric current is maintained through the tube. When electrons are accelerated by high voltages, as in **X-RAY** tubes, they acquire enormous speeds, comparable, though never equal, to that of **LIGHT**. Such electrons, upon striking a solid target, have part of their energy transformed into **X-rays**.

A beam of electrons passing through a vacuum may be deflected by electric or magnetic forces. The

ELECTRIC LOCOMOTIVE



1, 2, COURTESY NEW YORK CENTRAL LINES; 3, R. I. NESMITH AND ASSOCIATES PHOTO; 4, COURTESY CANADIAN NATIONAL RAILWAYS

ELECTRIC LOCOMOTIVES APPLIED TO VARIED SERVICES

1. Battery-Oil-Electric locomotive used in New York City for switching on the New York Central Lines. A 240-cell storage battery provides an auxiliary source of power.
2. Single unit locomotive used in New York Central freight service.
3. Electric locomotive on transcontinental passenger train of the Milwaukee Road between Chicago and Seattle.
4. Oil-Electric locomotive in passenger service on the Canadian National Railways.

amount of the deflection involves the momentum and, hence, the mass of the electron. By the use of measured electric and magnetic forces, this mass has been measured and found to be approximately 9×10^{-28} gram. The masses of atoms have been measured in similar experiments.

Of conduction through various solids, that through metals is the best example. Metals are distinguished from other substances by the ease with which electrons are detached from their atoms. Hence, a metal always has many free electrons which, under the action of an applied voltage, drift through the rather rigid "lattice" formed by the ATOMS. In a metal, the motion of the electrons is impeded by frequent collisions with atoms, seemingly being subject to the same laws as the MOLECULES of a gas diffusing through a pile of shot, with the modifications of the gas laws as required by the QUANTUM THEORY being especially important in the case of this "electron gas."

Conduction in liquid metals, such as mercury, is not different from other metallic conduction.

Conduction in liquid solutions, however, is another phenomenon. When a SALT or an ACID is dissolved in water, or in any liquid having a high DIELECTRIC constant, the salt or acid is almost completely dissociated. Each molecule is broken up into positively and negatively charged parts, called IONS, each ion having an excess, or a lack, of one or more electrons. The ions, either single atoms or groups of atoms, are much more massive than the electrons. Under the pressure of an applied voltage, they drift slowly through the liquid, presumably undergoing repeated recombinations and dissociations, and engaging, in some cases, in complex chemical reactions.

When a measured quantity of electricity is passed through a solution, the weight of matter used, in the form of ions, to carry the electric charge is directly proportional to the quantity of electricity and to the atomic weight of the element, and inversely proportional to its chemical VALENCE. The quantity of electricity is simply a measure of the total number of electronic charges carried by all the ions together. The valence of an element is identified with the number of electronic charges, either positive or negative, carried by one of its atoms when the atom is an ion. Hence, the greater the valence the smaller is the number of atomic carriers required for a given total number of electronic charges. Finally, the greater the weight of each atom, the greater is the weight of all the atoms together.

In a gas, the carriers of electricity are free electrons, positively charged molecules and negatively charged molecules. All of these together make a gas only slightly conducting under ordinary circumstances. However, if the electric field be sufficiently intense, or if the gas be sufficiently rarefied that a free electron may travel some distance without collision with a molecule, then the electron may be accelerated to such a speed that it will dislodge other electrons from the molecules it strikes. As these electrons are accelerated in turn, the action is cumulative. An electric spark

occurs or, in other cases, a continuous discharge (*see* ELECTRIC DISCHARGE) is maintained. In some collisions, even though an electron is not ejected, the molecule will be sufficiently disturbed to emit light, as in the lamps known in trade as Neon lamps (*see* GASEOUS CONDUCTOR LAMPS). R. T. C.

ELECTRICITY, Medical use of. *See* DIATHERMY.

ELECTRICITY SUPPLY. The principal sources of electrical energy are steam and WATER POWER, INTERNAL-COMBUSTION ENGINES and DIESEL ENGINES being used to a limited extent as PRIME MOVERS. Modern steam stations use turbine-driven alternators (*see* ELECTRIC GENERATOR) which generate energy at as low as \$0.005 per kilowatt-hour and cost approximately \$90 to \$125 per kilowatt of capacity. HYDRO-ELECTRIC Power stations have a low operating cost per kilowatt-hour but the fixed charges are large, the station costing approximately \$150 per kilowatt of capacity not including the costs of transmission lines and auxiliary steam stations. Thus, despite the lower operating cost, it is economically impracticable to develop many sources of hydroelectric power.

The following is an account of the power distribution voltages and phases: Direct current: 220-110 volts, 3-wire, for domestic lighting and power; 600 volts for municipal traction; 600 volts to 3,000 volts for railways; 2,000 to 4,000 volts for street-lighting circuits. Alternating current: 110 volts, 220-110 volts, 3-wire, for domestic use and lighting; 220 volts, 400 volts and 550 volts, 3-phase, for industrial power; 2,200 volts, 6,600 volts and 13,200 volts, 3-phase, for large industrial power; 2,000 to 5,000 volts for street lighting circuits; 11,000 volts, single-phase, for railways.

ELECTRIC LAMPS, devices for converting electrical energy to light. About 1710 Francis Hawksbee demonstrated to the Royal Society in London a machine which produced "electric light." It consisted of a hollow glass globe, from which the air had been exhausted, arranged so that it could be rotated rapidly. When rubbed with the hand while rotating it produced a glow of light.

Early in the 19th century, Sir Humphrey Davy discovered the basic principles of arc and incandescent lamps. Since then, the following general forms of electric lamps have been developed and used: (1) arc lamps, where the light is emitted by one or more electrodes heated to incandescence by the passage of electric current, (2) incandescent lamps, where the light is emitted by a filament heated to incandescence by current flow, (3) gaseous-conductor lamps, where the light is emitted by gases rendered luminous by the passage of an electric current.

See also ARC LAMPS; INCANDESCENT LAMPS; GASEOUS-CONDUCTOR LAMPS.

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ELECTRIC LIGHT BUG, the popular name for several species of giant water-bugs. So called because in flying from pond to pond, they are frequently attracted to lights. *See* WATER-BUG.

ELECTRIC LIGHTING. See ELECTRIC LAMPS; ILLUMINATION, ARTIFICIAL; ARTIFICIAL DAYLIGHT.

ELECTRIC LOCOMOTIVE, a LOCOMOTIVE powered by electric motors connected by gears or linkages to the driving axles. Usually, the current is conducted to the motors by contact shoes sliding on a third rail or by trolleys sliding along an overhead conductor. Such locomotives can exert considerable more draw-bar pull at low speeds than can the largest practical steam locomotives. In some of the later electric locomotives power is supplied the driving motors from a self-contained Diesel-electric power unit. Also, some electric locomotives receive their current from storage batteries. See STORAGE CELLS. H. M. H.

ELECTRIC MACHINE. See ELECTROSTATIC MACHINE.

ELECTRIC MANUFACTURING INDUSTRY, the enterprise of manufacturing equipment and devices for the production, transmission, distribution, and utilization of electric energy. This includes the manufacture of steam turbines, electric generators, switchgear and transformers, cable, insulators and other devices for transmission, transformers, regulators, lightning arresters, and the many kinds of apparatus and devices for supplying and utilizing the energy in transportation, electro-chemical processes, electric heating, lighting, and the many labor saving

ELECTRICAL MACHINERY MANUFACTURES, U.S. 1899-1929

Year	No. Establishments	Wage Earners	Wages \$	Value of Products \$
1899	581	42,013	20,579,194	92,434,435
1909	1,009	87,256	49,381,145	221,308,563
1919	1,404	212,374	238,188,852	997,968,119
1929	1,802	328,722	456,377,629	2,300,915,572
LEADING STATES 1929:				
Illinois	245	57,347	95,440,817	435,021,917
Pennsylvania ..	137	47,373	67,733,588	347,140,742
New Jersey ..	151	42,193	54,638,737	292,785,977
New York ..	211	36,267	46,170,298	264,359,741
Ohio	287	43,979	63,717,802	280,139,078
Massachusetts ..	106	28,844	41,011,734	184,786,944
Indiana	57	20,757	25,782,978	133,352,549

devices used in the home, in industry, and in agriculture. A large part of the electrical manufacturing industry is devoted to the material needed in the communications field (including telegraph, telephone and radio material), in the moving picture and talking picture industry and in medicine and surgery, such as X-ray and ultra-violet ray appliances.

ELECTRIC MEASUREMENTS. Measurements of electrical quantities may be either absolute or relative. An absolute measurement is made with an instrument which requires no calibration; the physical dimensions, length, mass, and time, of the instrument constitute all the data necessary to obtain the desired result. Such measurements are made only in special cases and for purposes of standardization; the instruments used are known as primary standards.

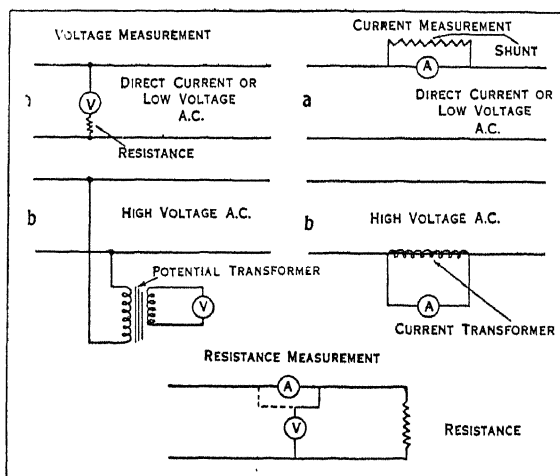
All ordinary electric measurements are relative, involving the use of calibrated measuring apparatus. Calibration is performed by checking against either a primary standard or against a secondary standard which has previously been calibrated. A secondary standard is simply a high-precision instrument made especially for calibration purposes.

Two general classes of measurements may be distinguished. The most common measurements are those of electric effects, such as current and potential. Another class of measurements frequently made involves the determination of the electrical properties of materials or apparatus. The measurement of electrical RESISTANCE, e.g., falls in this class. The measurements listed below are typical of the two classes.

Measurement of Potential. For most purposes, the ordinary VOLTMETER is the most convenient instrument for measuring potential. When connected between the points of which the potential difference is desired, it indicates the result directly on a calibrated scale. The instrument itself is accurate, rugged and convenient, and can be made for either direct or alternating-current measurements.

The procedure is modified somewhat when the voltage to be measured is large. In direct-current work, it is customary to connect known amounts of resistance in series with the instrument and apply a correction factor to the scale reading. With alternating-current voltages, a potential transformer may be used to "step down" the voltage by a known ratio and thus protect the operator and instrument.

All voltmeters require calibration either by means of some type of standard, or as is frequently done,



WIRING DIAGRAMS FOR ELECTRIC MEASUREMENTS

Voltage and current measurements are read directly, as in (a) or through instrument transformers as in (b). Resistance is commonly measured by the ammeter-voltmeter method shown above. To measure high resistances, voltmeter should be connected as shown in the dotted line. Connection for low resistance measurement is shown in full line.

by means of a POTENTIOMETER. The latter is a high precision device by means of which an unknown voltage can be compared with the known voltage of a standard cell.

Other methods of measuring voltage include the use of calibrated vacuum tube amplifiers (*see* TUBES, ELECTRONIC), THERMOCOUPLES, hot wires and spark gaps.

Measurement of Current. The AMMETER is the instrument most frequently used for current measurements. It is connected in a circuit so that the unknown current flows directly through the instrument, and the value of current is read directly on a calibrated scale. Ammeters are made for both direct and alternating-current measurements.

All but the most sensitive ammeters are used in conjunction with shunts, conductors which by-pass most of the current and allow only a small part to enter the windings. In high voltage, alternating-current measurements, it is customary to use a current transformer for protective purposes. Such a transformer is also used when a large, alternating current is to be measured, even though the potential of the circuit is low.

Ammeters are usually calibrated by means of a standard meter, CURRENT BALANCE or a potentiometer and standard-resistance combination.

Measurement of Resistance. The voltmeter-ammeter for measuring RESISTANCE method is based upon Ohm's Law, which states that: the resistance of a circuit in ohms is equal to the voltage across the circuit in volts divided by the current in the circuit in amperes. The method consists simply of measuring the voltage and current and dividing one by the other as stated.

Measurement of Inductance. The most satisfactory methods for measuring INDUCTANCE are bridge circuits (*see* WHEATSTONE BRIDGE) using alternating currents. The differences among the various methods lie chiefly in details rather than in principles. The means by which a balance is detected depends upon the frequency of the alternating supply used. At low frequencies, a vibration GALVANOMETER, or a galvanometer with an alternating field, is applicable; at higher frequencies, TELEPHONE receivers are usually employed.

Measurement of Capacitance. CAPACITANCE is usually measured either by bridge circuits similar to those used for inductance, or by direct comparison with a calibrated CONDENSER using a ballistic galvanometer. Larger sizes of condensers are often measured by the voltmeter-ammeter method with an alternating-current supply. *See also* WATTMETER; UNITS, ELECTRICAL.

W. H. T.

ELECTRIC MOTOR. *See* MOTOR, ELECTRIC.

ELECTRIC POWER GENERATION. *See* POWER GENERATION, ELECTRIC; POWER PLANTS.

ELECTRIC POWER INDUSTRY, the enterprise concerned with the generation, transmission and distribution of electric energy. The consumers comprise manufacturing industries, street lighting for municipalities, urban and suburban railroads and sections of main line railroads, agricultural industry and

domestic users of electric light and power. At the end of 1930 the capital invested in the electric power industry in this country amounted to approximately 12,000 million dollars, and it had been doubling in value every 6 or 7 years. In 1930, the total gross revenue of the industry amounted to over two billion dollars and in that year the industry required 285,000 employees. The output of electricity by central stations in 1930 was 90,000 million kilowatt-hours.

The electric power industry is subject to a certain amount of regulation by the Federal Power Commission and by state Public Service Commissions. *See also* ELECTRICITY SUPPLY. H. M. H.

ELECTRIC POWER TRANSMISSION. *See* POWER TRANSMISSION, ELECTRIC.

ELECTRIC RAILROAD SIGNALING. *See* RAILROAD SIGNALING.

ELECTRIC RAILWAYS, systems employing electric vehicles for the public transportation of passengers and merchandise. In the strict sense of the phrase electric railways include companies operating street cars, rapid transit cars, electric interurbans and suburban multiple-unit trains, all using continuous parallel track rails. The present broader interpretation includes trolley and bus lines and electrified main line railroads. Under the term "electric traction," gasoline electric buses and gasoline-electric or oil-electric rail cars and locomotives also would be listed with the other vehicles. In addition to the revenue-producing rolling stock electric railways have service equipment track, carhouses and repair shops, storage yards, overhead or third rail systems for distributing electric current, substations and generating plants, unless electrical energy is purchased.

For city and suburban service street cars, subway and elevated cars, trolley buses and multiple-unit trains are used, while for inter-city service interurban cars, both passenger and freight, and electrified steam railroad equipment are used. In the following table the extent of the physical facilities of the various types of electric railway operation, as well as the number of passengers carried and gross revenue received annually by each one, are shown:

	Number of Vehicles, Jan. 1, 1932	Track or Route Mileage Jan. 1, 1932	Number of Passengers Carried During 1931	Gross Revenue Received During 1931
City surface railways . . .	49,172	22,518	8,200,000,000	\$574,000,000
Rapid transit lines . . .	9,542	1,110	2,550,000,000	157,000,000
Trolley bus lines	225	183	41,179,000	1,623,000
Suburban railroads . . .	3,226	2,789	250,183,000	84,000,000
Interurban railways . . .	5,050	11,356	1,050,000,000	104,000,000

Street car is the term used to designate surface cars used only in city passenger service as distinguished from cars for suburban or interurban service. A surface car is one operated on tracks laid on the surface of the streets as distinguished from a car operated in a subway or on an elevated structure. The terms: surface car, street car and city car as commonly used are in general synonymous. With the exception of the cable cars in San Francisco all street cars are propelled by electric motors (*see* MOTOR, ELECTRIC) and employ

the same fundamental principle of operation for all electric railway vehicles. Current is collected usually from an overhead trolley by a wheel or shoe on the end of a trolley pole and conducted through the car roof to the controller (*see* CONTROLLERS, ELECTRIC). From the resistance coils used in conjunction with the controller the current passes to the motors and thence through the car truck to the track rails for the ground return. The motors, usually mounted on the car truck, are geared to the axles and propel the car. Stopping is effected commonly by air BRAKES although regenerative action of the motors (also known as dynamic braking), hydraulic brakes, rail brakes, and combinations of these have been developed.

Car bodies are of several types and sizes, depending on the service for which they are intended: closed; open; convertible, closed cars which can be opened; and California, closed in the center and open on both ends. Cars also are classified by number of decks, number of trucks, method of fare collection and whether they can be operated from one end or either end. Small capacity cars are mounted on a single truck of four wheels, but the majority have two trucks. Articulated units, using three trucks for two bodies have been developed for city surface and rapid transit use.

Elevated cars are designed for high-speed operation on structures above the streets and are entered usually from station platforms which are the same height above the rails as the car floor. Subway cars, for underground service, are similar to elevated cars, but usually larger and stronger. Cars for surface rapid transit and electrified suburban routes are of heavy construction also and built for high speeds. All of the cars in this classification, as well as many interurban cars, are operated in trains with multiple-unit control. With this system one operator in the first car handles a master controller which actuates the controllers in every motor-equipped car of the train.

Interurban cars, used in high-speed service between urban centers, are usually heavier, larger and stronger than city cars. They are designed for passengers, for freight or express, or for both.

TROLLEY BUSES are similar to street cars in that motors, control and a remote source of power are used, but require a second overhead wire for the electric return since they are mounted on rubber tires and do not use a track.

ELECTRIC LOCOMOTIVES are powerful tractive units, equipped with motors and commonly obtaining current from a distant generating plant, for hauling trains of cars or switching. They are used extensively by steam railroads on electrified portions of their main lines and by interurban railways for hauling freight cars. Oil- and gasoline-electric, storage battery and other types of locomotives have been developed for special needs.

Track for electric railways, the structure of two parallel rails for the flanged-wheel vehicles, is either "paved," when built in city streets, or "open," when

constructed on a private right-of-way. Depending on the type of service for which they are intended, the specifications adopted by individual companies and the kinds of materials used in electric railway track vary widely in their construction.

Electrical energy for railway systems usually is transmitted at high voltage from the generating plant to substations where it is transformed to lower voltages and converted to direct current, if direct current motors are used, by ROTARY CONVERTERS or MERCURY ARC RECTIFIERS. From the substations the current is transmitted through feeder lines to the overhead lines or third rails. A single overhead wire over the center of the track is used for almost all street cars and interurbans. In two cities, however, current is distributed through rails in an underground conduit between the two track rails. A third rail, paralleling the track, is used for current on many subway, elevated and electrified railroad lines. Where this system is employed sliding shoes, or collectors, are used instead of trolley poles in the case of an overhead system. A few interurbans and several electrified railroads use an overhead of the catenary type, in which the live wire is suspended from a cable structure. With the catenary construction most of the vehicles use a pantograph, a jointed frame with a transverse collecting bar, mounted on the roof.

Street cars, originally drawn on rails by horses or mules, were preceded by stages or omnibuses on the highways, also drawn by animals. The first horse railway, started on the Bowery in New York City in 1832, was the forerunner of a great era of this type of transportation. With the development of electricity and the adaptation of motors for propelling vehicles many practical types were brought out in the late eighties and the early nineties. Cable cars had been developed in the meantime and when electricity proved successful a large number of cable systems were in use. In the principal transition period of street car motive power from 1890 to 1902 horse cars diminished in number from 21,970 to 1,303, cable cars decreased from 5,199 to 2,396 and steam and other miscellaneous types dropped from 2,957 to 826, while electric cars increased from 5,592 to 65,583.

In a chronology of the industry the following dates are of importance: 1832—first American street car line, in New York; 1873—first street cable line, in San Francisco; 1884—first commercial electric railway in America, at Cleveland; 1886—Montgomery, Ala., was the first city in the world where street railways were run entirely by electricity; 1888—Richmond, Va. system with 40 cars, the largest installation to date; 1888—first commercial freight locomotive, in Connecticut; 1890—first permanent interurban line, between Minneapolis and St. Paul; 1895—first permanent all-electric elevated in America, at Chicago; 1899—first underground rapid transit line in America, at Boston; 1901—first American trolley bus demonstrated, at Boston.

The electrification of steam railroads began in 1895 when the New Haven Railroad started commercial service on its Nantasket Beach, Mass., line and

the Baltimore & Ohio Railroad started regular freight operation through an electrified tunnel in Baltimore. At the present time 23 steam railroads have electrified suburban or main lines, or both. At the beginning of 1932 these railroads had an electrified trackage of 4,901 miles and operated 578 electric locomotives, 2,506 motor cars and 949 trailers, equipped for operation with motor cars in trains. C. A. F.

ELECTRIC SHOCK, the severe muscular contractions caused by the passage through the human body of electric currents, usually of high voltage, often causing death through the failure of the contracted heart muscle to resume its action. It is generally believed that low tensions of from 110 to 120 volts are not fatal, while high tension currents cause death. Dr. H. Edenhofer has, however, recorded a number of deaths from as low as 46 volts and also has records in which 25,000 volts did not kill.

Much depends, of course, upon factors other than the amounts of voltage that are received. In time of disease the human body does not have the ability to resist the shocks of any kind that it has in health. Hence, that factor must be taken into account. The most important factors are the resistance of the skin to the electric current and the conductivity of the contacts between the body and the source of current. If the skin is quite dry, the conductivity is lessened and the resistance may be as high as 1,000,000 ohms. If, however, the hands and feet are perspiring, the conductivity is increased and the resistance is reduced to a few thousand ohms. Thus, numerous deaths have been reported from electric vibrators and heaters used in the bathroom when the person received house current at the time that hands and feet were thoroughly wet, thus absorbing much more of the electric current.

In these cases, an initial factor is that the water helped to make the connections between the live wire and the body. Likewise, workers in industry may have their hands covered with metallic dust, and this is likely to play a considerable part in the amount of current that is conducted to the body.

In view of these facts, electrical apparatus should not be disconnected with wet hands, and all sockets should be routinely inspected for imperfect connections. Caution is to be exercised, also, in case of fire around a live wire or electric apparatus, not to turn on a stream of water or chemical from a hand extinguisher without sufficient protection to the operator. In case a person working around live wires or a third rail has received a shock which rendered him unconscious, a rescuer attempting to pull off the body could himself be shocked and held fast. Unless the rescuer wears rubber gloves, he should knock or pry the body off with a stick of wood or other non-conductor.

Edenhofer records four types of death from electricity: first, sudden death; second, protracted; third, retarded, and fourth, delayed. In the first form, death strikes so suddenly that the individual does not even make an outcry. In the second form, he realizes the shock and may call for help, but death occurs in a

few minutes. In the third form, death is due to the effects; thus the person apparently recovers from the shock but soon thereafter passes into unconsciousness and death. In the delayed cases, which are rather rare, the symptoms do not come on for some hours or even for days after the person has had a shock.

When bodies of people dying from electric shock are examined after death, the conditions found vary. In some instances death occurs from suffocation due to the stopping of respiration, in others the brain and lungs are found filled with fluid, in some instances death seems to be due to sudden contractions of the heart without ability to relax and to continue the circulation of the blood through the body. Death due to electricity is not always due to shock, but sometimes to burning. Alternating and continuous currents produce different types of lesions in the central nervous system. Hemorrhages into the central nervous system are common after alternating current shocks but not after those from continuous current.

All authorities are convinced that no accident from electricity should be regarded as fatal until attempts at resuscitation through **ARTIFICIAL RESPIRATION** have been made for many hours. The person should be kept warm. He should be kept lying down and no attempts should be made to give anything by mouth until breathing is restored. M. F.

ELECTRIC SIGNALING, the term applied to the transmission of information by electric impulses carried over a metallic conductor or by electromagnetic waves (*see* **HERTZIAN WAVES**) propagated through the air. These impulses, or waves, are controlled by a mechanical device, as a telegraph key, or by a **MICROPHONE** actuated by sound waves. Systems which transmit signals by electrical impulses include: the **TELEGRAPH**, which sends impulses in correspondence to code, usually the **MORSE CODE**; **FIRE ALARMS**, which send impulses in correspondence to the number of the alarm box; **BURGLAR ALARMS**; and other special alarms designed merely to arrest attention by ringing a bell.

Wireless telegraphy is the transmission of signals by electromagnetic waves. It is used for the transmission of coded messages over land and sea and for the broadcasting of time signals to ships. All passenger-carrying ships are equipped with wireless telegraph apparatus and disaster is frequently averted by help brought by S.O.S. signals picked up by nearby ships or coast guard vessels. Ships which lose their bearings at sea can obtain their location by special wireless direction finders or by communication with land stations equipped with direction finders (*see* **RADIO BEACONS AND DIRECTION FINDERS**). Airplanes are kept on their course by radio beacons which send out a series of signals in such a manner that a receiving instrument on the plane indicates when the plane is flying in a direct line toward the beacon and when it is off its course. Wireless telephony or radio broadcasting are not, in the general sense, used for signaling but for communication. *See also* **SIGNALING**.

ELECTRIC TRACTION, a method of propelling vehicles on roads or rails by means of electric motors

mounted on, geared or in other ways connected to the driving axles. The current required by the motors is usually obtained from some source external to the vehicle, and is collected from a stationary overhead conductor or from a conducting rail at the ground level or in a slotted conduit. Less usually, the vehicle is independent of an external source of power and carries a storage battery or some form of fuel-consuming prime mover coupled to an electric generator which supplies electric current to the motors. The term "electric traction" is also sometimes applied to the electric propulsion of ships and canal boats.

Electric traction is superior to other forms of traction in the respect that it provides a greater starting pull, more rapid acceleration, smoother starting, regenerative braking, quiet operation and freedom from soot or smoke or other dirty and distasteful substances. Its chief disadvantages are high first cost and a tendency for the draw-bar pull to drop off rapidly with increasing speed. See ELECTRIC LOCOMOTIVE; ELECTRIC TRUCK; ELECTRIC RAILWAYS. H. M. H.

ELECTRIC TRAIN CONTROL. See RAILROAD SIGNALING AND INTERLOCKING.

ELECTRIC TRUCK, a motor vehicle propelled by electric motors mounted on or geared to the axles. It essentially comprises a steel framework carried on journal boxes and, in turn, supporting a superstructure of suitable construction for transporting freight. Power is supplied to the motor from storage batteries. See STORAGE CELLS.

ELECTRIC WAVES, disturbances in the ether produced by the oscillatory discharge of ELECTRICITY in a suitable arrangement of electric CONDUCTORS. (See ELECTROMAGNETIC WAVES.) The conductors, when charged, are surrounded by an electrostatic field which disappears when they are discharged. The discharge constitutes a transient current, this current being surrounded by a magnetic field which vanishes when the discharge ends. An oscillating discharge in an ANTENNA is accompanied by oscillating electrostatic and magnetic fields in the surrounding ether. These fields spread outward in all directions from the antenna with the velocity of LIGHT, and the resulting ether disturbances are called electromagnetic waves (see HERTZIAN WAVES).

Continuous waves, or waves of equal amplitude, are produced when each successive charge of the antenna is of the same magnitude and each successive transient discharge current is of the same intensity. Under such circumstances each successive magnetic and electrostatic field will be of the same intensity. DAMPED WAVES result when an oscillating system is left to itself when it begins to oscillate, so that succeeding oscillations are made at the expense of the energy held by the oscillating system. This energy is gradually exhausted, the amplitude of the oscillations becoming less and less and the resulting waves gradually dying away. An analogous case is that of a vibrating string which produces a musical tone (see SOUND). The electromagnetic waves which spread outward from an antenna carry energy, and the current oscillations in

the antenna produce heat, both effects taking place at the expense of the electrical energy. Hence, for undamped waves, provision must be made for a continuous supply of electrical energy to the antenna.

The *logarithmic decrement* of damped waves is a measure of the rate at which the electrical energy is dissipated. It is defined as the natural logarithm of the ratio of the amplitude of one vibration to that of the vibration next succeeding.

L. B. S.

ELECTRIC WELDING AND CUTTING.

See METAL CUTTING BY HEAT; WELDING.

ELECTRIFICATION, RURAL. See RURAL ELECTRIFICATION.

ELECTROANALYSIS, that branch of analytical chemistry which attempts to determine the composition of substances by electrical methods, principally by passing an electric current through a solution containing the substance to be investigated. Electroanalysis is restricted chiefly to those substances, chemical compounds or ores, which contain metals such as copper, zinc and aluminum, which can be easily isolated. By careful adjustment of the conditions under which the electric current operates upon the ionized particles in solution, it is generally possible to deposit but a single metal upon the electrode, while all others remain in solution, and thus separation of the constituents may be effected. See also ELECTROCHEMISTRY; ELECTRODEPOSITION.

ELECTROCARDIOGRAPH. See INSTRUMENTS, ELECTRICAL.

ELECTROCHEMICAL EQUIVALENT, the amount of any chemical element in grams, pounds, or other unit of weight, which is liberated by a definite quantity of electricity. Thus, for example, 1000 ampere hours of electricity will deposit on the cathode (one of the electrodes of an electrochemical cell) 8.8729 pounds of silver. This very fundamental and exact relation between the quantity of a chemical element and the quantity of electricity was discovered by the celebrated English scientist, MICHAEL FARADAY, in 1833.

In general, the electrochemical equivalent of any chemical element such as copper or iron or chlorine can be calculated with the aid of the following formulae:

$$\text{atomic weight} \times \frac{0.037308}{\text{valence}} = \text{grams per amp. hr.}$$

or

$$\text{atomic weight} \times \frac{0.082250}{\text{valence}} = \text{pounds per 1000 amp. hrs.}$$

In the above formulae, "valence" means the number of bonds per atom which hold it in combination with another element. Thus, in the salt, cupric chloride, CuCl_2 , copper (Cu) has a valence of 2 (it is divalent); and in the salt, cuprous chloride, CuCl , copper has a valence of one (it is monovalent).

C. G. F.

ELECTROCHEMISTRY, a division of chemistry which deals with the relations between, and the mutual transformation of, chemical and electrical energy. On account of the fundamental nature of

these relations and their wide and ever-increasing applications, electrochemistry has become a very important branch of chemistry.

Electrochemistry covers a wide diversity of subjects and as a matter of convenience the subjects may be grouped into two main divisions: To the first and older division belong the batteries, cells and other devices for producing electricity by chemical reactions; and to the second and more important division belong the vast number of chemical reactions and chemical products brought about by electricity.

Division I: A simple and well known case is the Daniell cell. This is composed of two poles, one of zinc and the other of copper, immersed in a solution of copper sulphate. Zinc passes into solution and it is the chemical energy produced by this reaction of the metallic zinc with the copper sulphate solution that is converted into electrical energy and can be used to operate an electric motor or light an electric lamp by merely connecting the outer ends of the zinc and copper poles with the two terminals of the motor or lamp.

Division II: A typical illustration is the electrical decomposition of a solution of table salt (NaCl). The two products are chlorine gas and caustic soda. The former is an important bleaching agent and war gas; the latter is used for making soap. Other examples are the production of pure copper from solutions of copper sulphate (blue vitriol), the formation of hydrogen gas (used to fill balloons) and oxygen gas by the electrical decomposition of water (H_2O), the electroplating of chromium, silver, gold, nickel and other metals; the interaction of sea sand with coal to form carborundum (SiC) a very hard material used for sharpening tools. Finally, such important materials as metallic aluminum and magnesium cannot be made except with the aid of electrochemistry. Our aeronautic and automotive industries would be impossible without electrochemistry. *See also* ELECTROANALYSIS.

C. G. F.

BIBLIOGRAPHY.—C. L. Mantell, *Applied Electrochemistry*; H. J. Creighton, *Principles and Applications of Electrochemistry*.

ELECTROCUTION. *See* CAPITAL PUNISHMENT.

ELECTRODE, a term applied in ELECTROCHEMISTRY to the metal conductor through which electric current flows into or out of a solution being subjected to electrical treatment (*see* ELECTROLYSIS). The electrode through which the current enters, that is, the electrode which is connected with the positive terminal of the source of electricity, is called the ANODE; the electrode by which the current leaves, the CATHODE. The use of the term "electrode" has been extended to other similar electric terminals, especially in vacuum (*see* RADIO TUBES) and X-ray tubes (*see* X-RAYS); as well as to those used in metallurgical operations (*see* METALLURGY). It might now be said, more generally, that an electrode denotes the terminal through which the electric current passes from a conducting into a relatively non-conducting medium, or vice versa. The form and nature of electrodes varies considerably and depends entirely upon the nature of the process in

which they are employed. Thus, in the electrolytic production of metals (*see* ELECTRODEPOSITION), such as copper, the cathode consists of pure copper, the anode of raw, impure copper; the action of the electric current, then, is to decompose the solution of copper salt through which it passes, depositing pure copper on the cathode and dissolving the impure metal from the anode. In the electrolysis of solutions, the anode is often attacked and corroded by such negative ions as chlorine; while in the electrolysis of fused metallic salts and hydroxides at high temperatures, the cathode may be destroyed by becoming alloyed with the metals deposited upon it. In the former case, electrodes composed of the "noble" platinum metals will satisfy most purposes; in the latter case, recourse must be had to carbon, graphite or similar substances.

W. J. L.

ELECTRODEPOSITION, the plating or depositing of a metal from a solution by means of direct electric current. Included in the field of commercial electrodeposition are electroplating, electrofining, electroforming or galvanoplasty, and electrowinning or the electrolytic recovery of metals from solutions obtained by the leaching of ores. Metals commonly electrodeposited are, cadmium, zinc, tin, nickel, copper, iron, chromium, silver, gold, and lead. Metals less commonly deposited are cobalt, platinum, rhodium, and palladium. Generally a soluble ANODE of the metal to be deposited is used as a source of metal to maintain the composition of the bath. Exceptions to this are chromium and the rare metals. In all instances of electrowinning, insoluble anodes are used.

Alloys of two metals may also be electrodeposited. The principal alloy so deposited is brass, from a solution of copper and zinc cyanides, the solution also containing excess sodium or potassium cyanide and sodium carbonate.

The article to be plated is the cathode or the electrode by which the current leaves the solution. *See also* ELECTROANALYSIS; ELECTROLYSIS. E. M. B.

ELECTRODYNAMICS, that branch of electrical science which deals with ELECTRICITY in motion, particularly with reference to the force actions between electric currents and the interactions between currents and magnetic fields (*see* MAGNETISM). In a more restricted sense, electrodynamics has to do with electric power and electric-power appliances, including generators, motors and the machinery of electrical transmission.

An ELECTRIC GENERATOR does not generate electricity in the sense that there is more electricity in existence after the dynamo is put into operation. Its action is to put into motion electricity that is already in the CIRCUIT. Moving electricity encounters RESISTANCE to its motion, and, in the action of overcoming the resistance, it produces heat. The process is roughly analogous to the production of heat by mechanical friction. An electric motor (*see* MOTOR, ELECTRIC) is essentially a dynamo running backward, the same magnetic forces acting upon the ARMATURE windings in both the dynamo and the motor. The armature of

the dynamo is turned against these forces, so that electricity is put into motion in the connected circuit. The armature of the motor turns with, and in response to, these forces, and a continuous supply of current is furnished to maintain them. L. B. S.

ELECTRODYNAMOMETER, a type of electrical measuring instrument used in **WATTMETERS** and in some **VOLTMETERS** and **AMMETERS** designed for alternating current measurements. Its principal feature is that two coils are employed, one fixed and the other movable, the latter carrying the pointer by which the value of the measured unit is indicated.

When used as a wattmeter, one coil carries a current proportional to the line current, and the other carries a current proportional to the line voltage. The force set up between the two coils rotates the movable coil against the force of a spring. As a voltmeter, the coils are commonly connected in series with each other and with a fixed resistance, while as an ammeter the series connection of coils is shunted by a fixed **RESISTANCE**. These resistances serve to protect the working parts from damage and to permit adjustment for calibration; they are used also in the wattmeter.

The scales of electrodynometers used as voltmeters or ammeters are not regularly divided, because the deflection of the instrument is proportional to the square of the current passing through it. Wattmeter scales are divided regularly, however, since for either constant current or voltage the deflection is directly proportional to the variable quantity.

W. H. T.

ELECTROLYSIS. When a salt, an acid, a metal or an alkali is dissolved in certain liquids, it suffers a process of decomposition, or **IONIZATION**. If a direct current of electricity is passed through this solution, the various constituents of the dissolved substance collect at the points where the current enters and where it leaves. This process is known as electrolysis.

In a water solution of **HYDROCHLORIC ACID**, for example, the **HYDROGEN**, **H**, and the **CHLORINE**, **Cl**, exist more or less free from the bond which held them together as **HCl**. The parts of **MOLECULES** set free in this manner are called **IONS**, and the solution containing them is said to be ionized. In the **HCl** solution, the **H** ion is an **Atom** which has lost one **ELECTRON**, and so has become positive; while the **Cl** ion has gained one electron, becoming negative. When a current from, e.g., an electric battery or a direct current generator, is passed through this solution, a migration of the ions takes place—the positive **H** ions move toward the negative terminal, or **CATHODE**, while the negative **Cl** ions move toward the positive terminal or **ANODE**. At the negative terminal, hydrogen collects as a gas, and at the positive terminal, chlorine gas gathers.

In pure water, there are no ions to act as current carriers, so pure water will not conduct electricity.

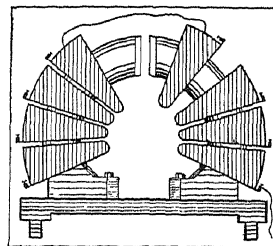
In a solution of a metallic salt, the metal forms the positive ion and so may be deposited on the cathode in the free metallic state, as e.g., in a solution of copper sulphate the copper will be deposited on the

cathode to form a plate of pure copper. This action is, in effect, the process of electroplating. If the **anode** is made of copper, the acid radical, or negative ions, will migrate to it and combine with it to form fresh copper sulphate, thus renewing the solution. Commercially, this process is employed to refine metals, to prepare many chemical substances, and to **ELECTROTYPE**. See also **METAL COATINGS**. L. B. S.

ELECTROLYTES, solutions which conduct electricity and which are decomposed upon the passage of current. In electro-chemistry, acids, bases and salts are known as the electrolytes, since their solutions exclusively possess the above characteristics.

ELECTROMAGNET, essentially a coil of insulated, electrically conducting wire wound about iron cores. A current flowing in the coil of an electromagnet sets up a magnetic field (see **MAGNETISM**), the strength of which is increased by the presence of the iron core which provides a ready path for the magnetic lines of force.

The greatest magnetic flux is obtained when the iron core is a closed circuit, and, in general, the best form for the coil of an electromagnet is an open ring or "horseshoe." A very useful form of electromagnet is shown in the accompanying figure; it is known as the duBois half-ring electromagnet. Weiss, using ferrocobalt tips on the poles of his electromagnet, was able to obtain a field strength of 50 to 60 kilogausses. The largest electromagnet in the world is the 85-ton electromagnet at the University of California. See also **INDUCTION**; **INDUCTION COIL**.



DUBOIS HALF-RING ELECTROMAGNET

ELECTROMAGNETIC INDUCTION. See **INDUCTION**.

ELECTROMAGNETIC SPECTRUM, an arrangement of electromagnetic radiations in the order of their **WAVE-LENGTHS**. Radio waves, or **HERTZIAN WAVES**, are produced and received by means of electrical **CIRCUITS**. Subdivisions are as follows: long waves, 30,000 to 545 m. at **FREQUENCIES** of from 10,000 to 550,000 cycles per sec.; broadcast waves, 545 to 200 m. at 5.5×10^5 to 15×10^5 cycles per sec.; short waves, from 200 to 2 m. at 1.5×10^6 to 150×10^6 cycles; and ultra-short waves from 2 m. to 0.008 cm. at 1.5×10^8 to 3.7×10^{12} cycles per sec.

Heat waves are produced by hot bodies, due to their atomic movements, and are detected by means of **THERMOCOUPLES**, thermometers, and **BOLOMETERS**.

Visible light rays, which range through the spectrum in the order: red, orange, yellow, green, blue, indigo and violet, are produced by the movements of the outermost **ELECTRONS** in **ATOMS**. They are detected by the eye, by photographic plates and by photoelectric and chemical action. They make but one octave in the total spectrum of about fifty octaves.

The ultra-violet rays, which have definite actinic

properties, are produced in the same way as light rays and are detected by photographic plates and by chemical, photo-electric and luminescent action.

The extreme ultra-violet rays are produced by the movements of electrons in atoms from which outer electrons have been removed. They are detected by their photographic action and are studied in a vacuum, since they are absorbed by a small trace of air.

X-RAYS arise from the sudden stopping of high-velocity electrons or from the movements of electrons near the nuclei (*see* NUCLEUS) of atoms. They are detected by photographic plates, by their ionizing action and by luminescent screens (*see* LUMINESCENCE).

GAMMA RAYS arise spontaneously in the nuclei of certain radioactive substances (*see* RADIOACTIVITY) and are detected by the same means as X-rays. They are more penetrating than X-rays.

The most highly penetrating rays known come from inter-stellar space, and are called cosmic rays. They are studied by the IONIZATION which they produce.

J. B. H.

periments, its correctness in relation to electric and magnetic disturbances, and by his work laid the foundation of radio communication. (*See* HERTZIAN WAVES.)

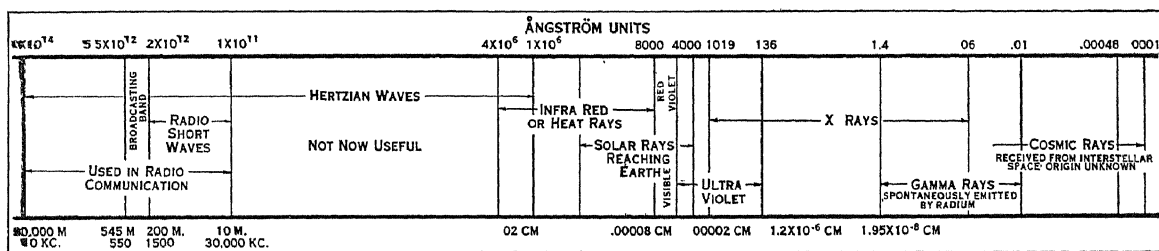
Because this theory shows clearly why good conductors, such as metals, are good reflectors, as well as possess so many other optical properties, it is the most satisfactory ever proposed.

The theory has been the stimulus of an enormous amount of informative research and speculation, presenting an entirely new view of physical laws used in physics and electrical engineering.

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ELECTROMAGNETIC WAVES. *See* ELECTROMAGNETIC SPECTRUM; ELECTROMAGNETIC THEORY OF RADIATION; HERTZIAN WAVES; ELECTRIC WAVES.

ELECTROMAGNETISM, a collective term embodying all the relations which exist between ELECTRICITY and MAGNETISM. Oersted demonstrated, in 1820, that an electric current flowing in a wire produced a magnetic field. That the motion of static



COURTESY, ELECTRONICS

ELECTROMAGNETIC OR ETHER SPECTRUM

Showing graphically the type of radiation at various wave-lengths

ELECTROMAGNETIC THEORY OF RADIATION, an explanation of ether radiations as electric and magnetic wave phenomena, stated by MAXWELL. The theory is applicable to all WAVE-LENGTHS from those used in RADIO COMMUNICATION up through those of HEAT and LIGHT waves and of ultra-violet rays and X-RAYS to those of the recently discovered COSMIC RAYS. It considers the ether wave not so much as a physical motion of the medium but as a periodic change in the strength of the electric and the magnetic fields, the field being propagated in all directions with the velocity of light. Maxwell, in 1865, set up equations, based on fundamental conceptions and definitions, representing the conditions in the neighborhood of electric charges or magnetic poles. When these were so stated as to include electric or magnetic disturbances, they resulted in the form of the equations of a wave. Maxwell concluded, therefore, that electric and magnetic field disturbances were transmitted as waves through the ether as a medium. Prior to the work of Maxwell, it was believed that electric and magnetic intensity were propagated with infinite velocity. Since the velocity as given by the equations was the same as the velocity of light, Maxwell concluded that light was an electromagnetic phenomenon.

The importance of Maxwell's conclusions was not recognized until Hertz, in 1890, demonstrated, by ex-

perimenting with electricity also produces magnetic fields, was proved by Rowland, who caused a field to be set up by rotating an electrically charged disk at high speed. In 1831, FARADAY showed that if the number of magnetic lines of force which were linked with an electric CONDUCTOR were varied, an electromotive force would be induced in the conductor. His epochal experiment comprised thrusting a magnet into a coil of wire (*see* INDUCTION COIL) which was connected to a GALVANOMETER, the deflection of the galvanometer showing that an electric current was produced.

The experiments of Oersted and Faraday established the fundamentals of electromagnetism. Wherever electricity is in motion, magnetic fields will be produced; wherever the magnetic flux linked with a coil varies, electromotive forces will be induced. On these principles are based all of the modern electric light and power developments.

S. R. W.

ELECTRO-METALLURGY may be described in two divisions: (a) preparation of metals from their ores, (b) manufacture of iron, steel and other metals in the electric furnace.

From the first disclosure of the electric arc by Davy in 1800, men began experimenting with the effect on different chemicals and minerals of the extremely high temperature thus made available. Practical electro-metallurgy, however, had to await the development

of the electric dynamo to provide sufficient quantities of low priced power.

Fortunately the ores of many of the important metals are oxides or can be converted to oxides by roasting. Nearly all the electro-thermal metallurgy of ores revolves around the fact that oxides are reduced to the metal when heated to a sufficiently high temperature in the presence of carbon. In some cases the temperature required is so high that it is not practical to reduce the oxide commercially except in the ELECTRIC FURNACE. Vanadium is a case in point. Silicon, manganese, chromium, tungsten, vanadium and molybdenum are used in steel making in the form of alloys of iron (*see IRON, alloys*) prepared by smelting the ore mixed with coke and steel scrap in a submerged arc furnace.

There is a small scale electric production of pig iron from ore. Aluminum is prepared by electrolysis of an electrically heated bath of molten salts.

The electric furnace, first applied to steel making by William Siemens about 1882, has developed to an industry of approximately 650 arc furnaces in the United States and Canada in 1930 with over 1,000,000 tons yearly output. About one-third of all the steel for castings in the United States is now electrically melted. The electric furnace has recently been applied to grey, malleable and alloyed iron. Heat resistant and stainless steels are important electric furnace products. Most of the brass for rolling mills is electrically melted. G. L. Si.

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ELECTROMETER, an instrument used principally in the detection and measurement of electric potential. It operates by reason of the mechanical force exerted between charged bodies (*see ELECTRICITY*), such as metallic plates or filaments.

One important type is known as the quadrant electrometer. A circular metal box is cut into four sectors, or quadrants, and a metallic vane, or needle, is suspended on a torsion fiber within the box. The usual method of operating it is to apply a fixed potential difference between alternate quadrants of the box and to apply the potential difference to be measured between the vane and one pair of quadrants. The deflection of the vane is detected and measured by a beam of light reflected from a mirror mounted on the torsion fiber. The instrument may be employed for either direct or alternating-current measurements; in either case, it is necessary to calibrate it against a standard instrument.

ELECTROMOTIVE FORCE. *See* POTENTIAL, ELECTRIC.

ELECTRON, the elementary particle of ELECTRICITY and of the ATOM. It is defined in terms of three properties: its ELECTRICAL CHARGE, its mass and its WAVE-LENGTH.

The charge is negative and extremely small, the precise value, as given by the oil-drop experiment of MILLIKAN, being 4.770×10^{-10} electrostatic units. This is approximately one-billion-billionth of the elec-

trical charge needed to operate a 25-watt incandescent lamp for one second.

The isolation and measurement of the electron was accomplished by spraying a few drops of oil into the space between two horizontal metal plates. Such drops are found to be electrically charged and may be prevented from falling to the lower metal plate by connecting a BATTERY to the plates so as to attract the drops upwards. The amount of electricity on the drop of oil is then measured and is found to be either a certain small amount representing the charge of a single electron or any integral multiple of this amount. This means that, if observed on a fine enough scale, electricity is made up of minute particles, like the sand on a beach.

The mass of the electron is 9×10^{-28} grams, or about two-million-trillion-trillionths lb. This has not been measured directly but is determined from the ratio of the charge to the mass, e/m , of the electron. A stream of electrons, called a CATHODE RAY, is bent from its straight-line path when passed through electric and magnetic fields (*see ELECTRIC FIELD; MAGNETISM*). From the strengths of these deflecting fields and the amount of the deflection, it is possible to calculate the ratio e/m . This is found to be 1.76×10^7 electromagnetic units per gram. Knowing the electrical charge of the electron the mass may then be calculated.

Electrons which are reflected from a single crystal, or which pass through extremely thin films of gold, silver, collodion and other substances, spread out, or are diffracted (*see DIFFRACTION*), in a manner similar to X-RAYS. Caught on a photographic plate, they exhibit patterns which can only be interpreted by assigning a wave of definite length to the electron. This electron WAVE-LENGTH, approximately 0.05 ÅNGSTRÖM UNITS, is about the same as that of GAMMA RAYS or of penetrating X-rays. However, it is not always the same, even for a given electron, but changes with the velocity of the electron. The faster an electron travels, the shorter will be its wave-length. De Broglie has shown that the wave-length, λ , is given by the equation $\lambda = h/mv$, where h is Planck's constant (6.55×10^{-27}) (*see* PLANCK'S LAW), m is the mass of the electron and v is its velocity.

In view of the three known properties of the electron, it is possible at one time to treat it as a charged particle and at another as a wave. J. B. H.

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ELECTRONICS. The ELECTRON theory explains all electrical phenomena in terms of the ELECTRON, or negative particle of electricity. The fluid theory may still be given as a qualitative explanation of the flow of electricity through a metallic CONDUCTOR, but to account for numerous recent discoveries electricity must be considered as consisting of discrete particles. Conduction of electricity (*see ELECTRICITY, CONDUCTION OF*) through gases, emission of electricity from hot bodies (*see ELECTROMAGNETIC THEORY OF RADIATION*), photo-electricity (*see PHOTO-ELECTRIC CELL*)

and RADIOACTIVITY are some of the new developments grouped under the general heading of electronics.

Experiments on the conduction of electricity through gases gave the first evidence that an electric current consists of a stream of discrete particles. Gases at atmospheric pressure are poor conductors, but at reduced pressure they readily pass an induction coil discharge. The study of CATHODE RAYS added much to the knowledge of the behavior of the particles of electricity. Cathode rays are emitted at the negative electrode. They are invisible, are detected by their fluorescent effects and may be deflected from a straight path by electric and magnetic fields. Thomson crossed electric and magnetic fields to show conclusively that the cathode rays are streams of electrons passing through the discharge tube with high velocity. By measuring the ratio of the charge of the electrons to their mass, he found it to be the same for all electrons, regardless of the gas and electrodes used.

The cathode rays became of great practical importance after the discovery of X-RAYS. X-rays are generated when high velocity electrons are suddenly stopped by striking a target; they are of very short WAVE-LENGTH, and the shorter the wave-length the more penetrating are the rays. The penetrating power or "hardness" increases with the velocity of the electrons striking the target.

Heat and Electronics. Electrons evaporate from a heated wire, or FILAMENT, much in the same way that molecules leave the surface of water in an open container. As the temperature is raised, the rate of evaporation increases. The emission proceeds best in an evacuated bulb containing the filament and an insulated metal plate which is kept at a positive potential by means of a BATTERY; the negative terminal of the battery is connected to the filament. Electrons leave the heated filament, are drawn to the positive plate through the evacuated space and complete the circuit through the plate battery and the filament. The COOLIDGE TUBE is essentially the same as that just described, having a filament connected to an external source of current and a target kept at a high positive potential. Electrons emitted from the hot filament, or cathode, are accelerated across the tube and strike the target with high velocity, causing X-rays to be emitted from the target. The intensity of the X-rays depends upon the temperature of the filament, while their penetrating power depends upon the potential applied to the target.

Light and Electronics. When light shines upon metals, electrons are given off. This phenomenon is called the photo-electric effect. The number of electrons emitted depends on the intensity of the exciting light; the velocity with which the electrons leave the metal increases with the frequency of the light. The most active metals are the ALKALIES, especially POTASSIUM and SODIUM. To study the effect, an evacuated glass bulb is used, the bulb containing a plate covered with the active metal and a second ELECTRODE, or collector, which is kept at a positive potential. When the photo-electric metal is exposed

to the exciting light, electrons are given off and proceed to the collector. The response is practically instantaneous, so that the slightest variation in the intensity of the light is reproduced immediately in the photo-electric current. It is this property of the photo-electric cell that makes it so important in TELEVISION and allied applications.

Electronics of Nature. The electronic phenomena thus far described have dealt with the artificial emission of electrons, definite conditions having to be fulfilled before the electrons are emitted. Radioactive substances, such as uranium, radium and thorium, give off electricity spontaneously and continuously. Radium and its products give off ALPHA RAYS, BETA RAYS and GAMMA RAYS. The alpha rays are atoms of HELIUM which have lost two electrons and thus carry a double positive charge. The beta rays are electrons of extremely high velocity. The gamma rays are similar to X-rays but have a much greater penetrating power than the "hardest" X-rays hitherto produced.

Radium, a metallic element, gives off ALPHA PARTICLES to become a new element, radium emanation, or radon, a dense, inactive gas. Thus the transformation from one element to another goes on continuously in nature among the radioactive substances. The structure of matter is intimately bound up with electricity, as is evidenced by the fact that the liberation of alpha and beta particles brings about a complete change in the physical and chemical properties of the liberating elements.

R. T. C.

ELECTRONIC SPECTRUM. See ELECTROMAGNETIC SPECTRUM.

ELECTROPHORESIS, the movement, under the influence of an electric field, of solid particles suspended in a liquid. The potential difference at the surface or interface where a solid touches a liquid causes an electric charge on the solid. Adsorption of charged ions is a factor. In a glass tube of capillary size filled with water, the wall of the tube is negatively charged while the water is positively charged. If electrodes are placed at the ends of the capillary tube and a direct current of electricity passed between them, the water (positively charged) is attracted to the negative electrode and a stream of water actually moves in that direction. If a porous clay wall is used, the effect is the same; water moves through the capillary channels of the porous membrane. This movement of the liquid through a fixed solid wall under electric stress is termed "electric osmose." If glass or clay be ground into very small particles and suspended in water, the solid particles themselves will move toward the positive electrode because of their negative charge. This phenomenon is wrongly called "cataphoresis," because in some instances suspended solid or liquid particles (even bubbles) move to the cathode. Since in other instances particles may move toward the anode, depending upon the nature of the charge, the general term *electrophoresis* should be used.

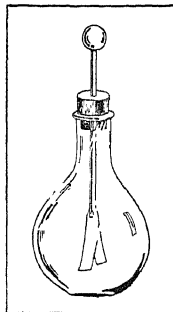
By electrophoresis one can recognize the nature of

the charge on a suspended particle, for a positive particle always migrates to the cathode, and a negative particle to the anode.

H. N. H.

ELECTROPLATING. See METAL COATINGS; ELECTROLYSIS; ELECTRODEPOSITION.

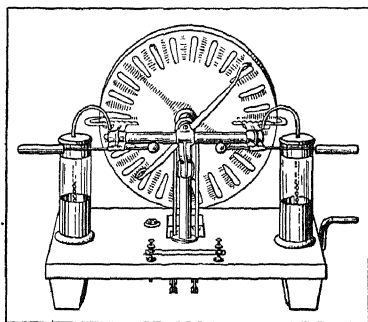
ELECTROSCOPE, an instrument used for the detection of an ELECTRIC CHARGE. It consists of a strip of metallic foil suspended midway between its ends on a horizontal wire support, so that the two halves hang vertically and in the same plane. When the supporting wire is touched, or otherwise influenced by a charged body, the two parts of the strip acquire like charges and move apart due to electrostatic repulsion.



ELECTROSCOPE

ELECTROSTATIC MACHINE, a machine which operates by electrostatic induction and converts mechanical into electrostatic energy by the transfer of ELECTRONS from one CONDUCTOR to another against electrostatic attraction. The action of such machines is illustrated by the Wimshurst Machine, shown in the accompanying figures. Two parallel disks rotate in opposite directions on the same axis. These disks have equal diameters, but, for purposes of illustration, are shown as concentric cylinders, *A* and *B*. Tinfoil sectors, such as *S*₁ and *S*₂, shown on the cylinders, are spaced uniformly around the outer side of each of the disks.

When the cylinders begin to rotate, the upper sectors on the inner cylinder, *A*, e.g., acquire a slight

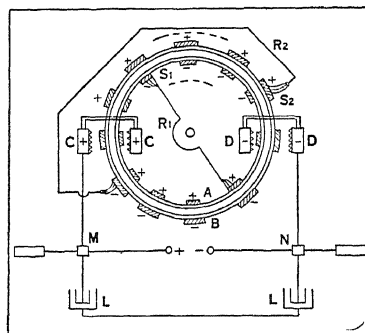


WIMSHURST ELECTROSTATIC MACHINE

negative charge through friction with the upper brush of the conducting rod, *R*₁. These charged sectors, shown moving clockwise in the figure, induce a + charge, in succession, on corresponding sectors of the outer cylinder as these sectors pass by the upper brush of the conducting rod, *R*₂. The induced charges are in turn carried past the upper brush of the rod, *R*₁, and induce charges on it and on the sectors with which it is in contact. The augmented charges on the sectors of the inner cylinder now induce increased charges on the sectors of the outer cylinder as they pass the brush, *S*₂. In this manner the charges on all the sectors continue to increase until the potential becomes such that all the electricity transferred is lost

by brush discharges or by conduction over the insulating surfaces.

When the induced negative charges flow from the rod, *R*₁, onto the upper segments of the inner cylinder,



SCHEMATIC WIRING DIAGRAM OF WIMSHURST ELECTROSTATIC MACHINE

simultaneously the induced positive charges are transferred from the other end of the rod to the lower segments of the inner cylinder. In a similar manner, negative charges are transferred from the rod, *R*₂, to the lower sectors of the outer cylinder. On both the cylinders, the + charges move toward the collector, *CC*, and the — charges toward the collector, *DD*. Before the potentials are reached at which the sectors lose as much charge as they gain, their charges begin to be collected by the sharp points on the collectors or by brushes attached to these collectors.

The collectors are connected to two LEYDEN JARS, *LL*, in series, as shown in the figure. These jars greatly increase the CAPACITANCE of the collectors.

The quantity of electricity and the amount of energy involved at each discharge between the knobs, *M* and *N*, notwithstanding the comparatively high potentials of the collectors, is small.

A. Z.

ELECTROSTATICS, that branch of the science of ELECTRICITY dealing with the properties of electricity at rest. The two most important facts in electrostatics are: that there are two kinds of static charge, positive and negative; and that between any two static charges there is a force action, repulsive for charges of the same kind and attractive for charges of the opposite kind, the magnitude of the force depending upon the size of the charges, the distance between them and the nature of the intervening medium. This relation is utilized in formulating the definition for the electrostatic unit charge. Unit charge is that charge which, concentrated at a point in a vacuum, will repel an exactly similar charge at a distance of one centimeter, with a force of one DYNE.

According to the ELECTRON theory, all bodies possess electricity at all times and there is no portion of matter entirely free from electricity. Hence, a neutral body is a body in which both positive and negative electricities are present in equal amounts. Any charging process is, therefore, a process by which this equilibrium of positive and negative charges is disturbed.

Electrostatic charge may be developed by friction, as when a glass rod is stroked with silk. In this operation, electrons are transferred from the glass rod to the silk. Since electrons are negative, the silk will now exhibit a negative charge and the glass rod a positive one. Another method of charging a body is **INDUCTION**, in which a charged body is made to approach a **CONDUCTOR** without actual contact therewith. The explanation is that the inducing charge causes a displacement of the electrons of the conductor, increasing the number in one region and decreasing that in another. If these regions are neutral at the outset, they will be charged. L. B. S.

ELECTROSTATIC SEPARATOR, in **ORE TREATMENT**, a machine used to separate valuable **ORE** from **GANGUE**. The ore is passed over an electrically charged roller, the mineral particles being electrically charged at rates varying with their conductivity. The resultant attractive and repulsive forces cause different minerals to separate from each other and fall into different receptacles.

ELECTROTYPING, a process for the duplication of printing forms. It has proved most satisfactory, because the plates can readily be curved to fit rotary cylinders, they present an acceptable printing surface, and they can be produced with comparative speed and economy.

The forms are surrounded with bearers, and locked in a strong chase for moulding under a powerful hydraulic press. The impression is received on a case, a thick sheet of mineral wax mounted on sheet metal. The details of the form are deeply impressed into the smooth wax surface, which becomes the mould upon which the "shell" is formed by **ELECTROLYSIS**. After certain preparatory operations the mould is sensitized with a graphite coating to render it electrically conductive.

The battery is a vat filled with a solution of copper sulphate, into which the mould is suspended from the negative pole of a direct current circuit, a bar of pure copper being likewise suspended from the positive pole. Action of the electrical current causes the bar to be disintegrated, and a thin film of the copper to be deposited on the mould. In two to four hours this shell is heavy enough to be stripped from the mould. It is now an exact duplicate of the printing surface of the form, and, when backed with melted metal, is a plate. The finishing operations consist in leveling the surface, shaving to required thickness, trimming, and mounting on a wood or metal base when necessary. Then the plate is ready for the press-room.

With the proper solution in the battery, nickel may be used instead of copper, producing a more durable plate and one that is non-corrosive in contact with certain inks that attack copper. For moulding halftones, sheets of soft lead are often used instead of wax cases. E. W. P.

ELECTRUM, a natural alloy of silver and gold, usually containing 18% to 36% silver. It is pale yellow to yellowish white in color. Electrum is derived

from the Greek for amber, and was probably applied to this alloy because of its pale amber color when compared with gold. Pliny states that the alloy was called **electrum** when it was one-fifth silver. It is an **ORE** found in some gold mines in Siberia, New Granada, Peru and, in the United States, in California and Virginia. See also **GOLD**; **SILVER**; **METALS**, **NATIVE**.

ELEGY, a short poem expressing either grief for a deceased person or a sense of the pathos of death, written originally in the so-called elegiac distich, the first line of which is a hexameter, the second a pentameter. The Greek elegies were less funereal than dedicated to love and war, and it is noteworthy that the dirges of **BION** and **THEOCRITUS**, very typical elegies, were called idylls. Of the Roman elegists, the three foremost were **PROPERTIUS**, **TIBULLUS** and **OVID**. The noblest elegies in English are **SPENSER'S Daphnida**, 1591; **MILTON'S Lycidas**, 1638; **GRAY'S** ever-famous *Elegy Written in a Country Churchyard*, 1750; **SHELLEY'S** *ADONIS*, and **ARNOLD'S Thyrsis**, 1867. See also **GREEK**, **LATIN**, **ENGLISH LITERATURE**.

ELEKTRA, an opera in one act by **RICHARD STRAUSS**, libretto based on the Greek by **HUGO VON Hofmannsthal**; première, Dresden, 1909. It is one of the best known of Strauss's operas, standing second only to *Der Rosenkavalier* and *Salome*.

Clytemnestra, wife of **Agamemnon**, king of **Argos**, has murdered her husband with the aid of her paramour **Ægisthus**. To avenge her father's death, **Elektra** determines to kill her mother and **Ægisthus**. Her brother **Orestes** is believed dead, and her sister **Chrysothemis** will not aid her. Upon **Elektra** alone therefore falls the duty of avenging her father's murder. She is upon the point of slaying **Clytemnestra** and **Ægisthus** when **Orestes**, the report of whose death had been fabricated, returns home. The ax with which **Agamemnon** had been struck down is placed in her brother's hand by **Elektra**, and he pursues **Ægisthus** through the palace until he kills him, having previously slain his mother **Clytemnestra**. Meanwhile **Elektra**, having vicariously sated her thirst for blood, begins to dance with frenzy, continuing ever more wildly until she dies from exhaustion.

ELEMENTARY EDUCATION. A general term employed to refer to that education which is given to pupils within the compulsory age limits, normally between the ages of 6 and 14. The concept of elementary education has been colored by its tradition as that education intended to impart the elements in the fundamental tool subjects, reading, writing and arithmetic. In the United States for a large part of the 19th century and in other countries generally elementary education has connoted the education of the children of the masses. Even with this connotation the scope of the elementary school curriculum began to be expanded beyond the rudiments before the close of the 19th century and to include history and geography, elementary science, music and drawing, and physical training. For the children of the well-to-do in countries outside of the United States a parallel system was provided leading directly to the

secondary schools. The United States has been the only country in which elementary education was definitely articulated with the secondary. There is to-day a widespread tendency to adopt the general principles of the common school system with a consequent change of terminology: the term elementary education to be replaced by the term primary education, on which some form of secondary education will be built beginning at the age of 12. This recognition of the primary school as the school for all the children of all the people is accompanied by considerable experimentation in methods and curriculums which look to the improvement of all as individuals and as potential citizens. See PUBLIC SCHOOLS; EDUCATION, THEORY OF.

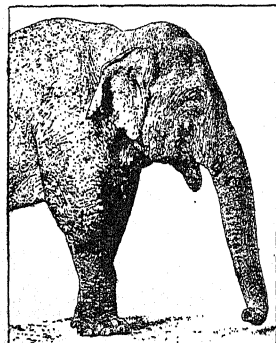
I. L. K.

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ELEMENTS, CHEMICAL. See PERIODIC SYSTEM OF CHEMICAL ELEMENTS.

ELEPHANT, an animal of the family *Elephantidae* in the order *Proboscidea*; a proboscidean. Elephants are descendants of a very ancient race, having developed from primitive small ancestors lacking a trunk or visible tusks, into the huge long-trunked MAMMOTH, MASTODON and modern examples. The proboscis or trunk (the nose) necessarily is adapted in its present length so that the short-necked, unbending beast has some means of gathering food and passing it into its mouth. The survivors of this race, once

more widely distributed than now, comprise only two species: the Asiatic elephant (*Elephas indicus*) of India, Ceylon, and eastward to Cochin China and Sumatra, and the African elephant (*E. africanus*). The Indian elephant is the one most familiar to us by sight and in history and legend. It rarely exceeds 10 ft. tall at the shoulder, but "Jumbo" was 11 ft. tall and weighed 6½ tons. It has a concave forehead, comparatively small ears



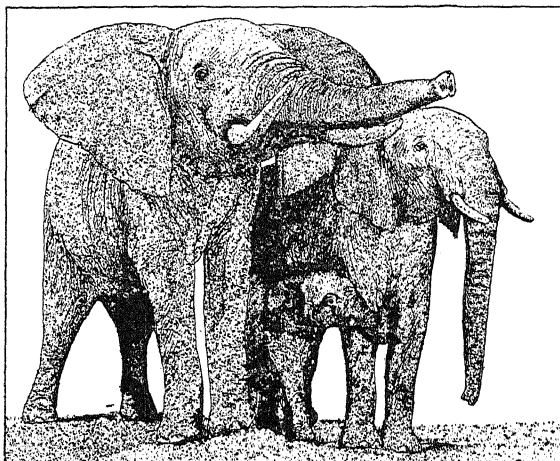
COURTESY AMER. MUS. OF NATL. HISTORY

INDIAN ELEPHANT
Head of female

and tusks, and only one finger at the tip of its trunk. The African elephant is perhaps a little larger, has a convex forehead, longer tusks which are present in both sexes in each species, two trunk-fingers, and ears which, when folded back, are so broad as to cover the shoulders.

Elephants are forest-lovers, and are especially fond of mountainous country. They associate in family parties that often unite into small herds, each apparently managed by a leader. The Asiatic species keeps to the depths of the forest and hills, and seems less inclined to move about than its African relatives,

which are noted for wide wandering. Both kinds delight in water, and resort to it for drink and baths as often as possible. Animals so big must spend most of their time in feeding, and stay where food is abundant, browsing on the leaves and twigs of trees, digging up roots and edible bulbs, despoiling palms of their fresh shoots and ravaging the crops and gardens of native farmers. They are long-lived, yet stories of an age beyond a century must be doubted. They attain maturity at about the twenty-fifth year, and thereafter the females produce offspring once in two or three years. Births among the captive ele-



AFRICAN ELEPHANT GROUP IN THE AMERICAN MUSEUM OF NATURAL HISTORY, NEW YORK

phants in the East are rare, except in the breeding stations maintained by the government of Siam.

Since antiquity the Indian elephant has been tamed by men and made a beast of draft or burden, and of service in war and sport; but the African remains wild, although utilized anciently in Carthaginian and Roman armies. The flesh of both is much relished by savages, and both have furnished civilized men with ivory for thousands of years. Because of their slow and infrequent reproduction, the multitude of elephants required for work in the Orient must constantly be renewed by captures from wild stock, for which elaborate official arrangements exist; and the herds everywhere are now under governmental protection. Among Hindoos the elephant, personified as Ganesha, was superior to all other animals, and formerly was paid religious veneration; while an albino variety still holds a semi-sacred eminence in Siam. The elephant is generally considered the most intelligent of all animals, but its sagacity is probably exaggerated, despite the visible evidence of its docility and even ingenuity in performing tasks to which it has become trained. See MAMMOTH; MASTODON. E. I.

ELEPHANT BUTTE DAM, located on the Rio Grande about 120 miles northwest of El Paso, Tex., is a non-overflow, gravity type, rubble concrete structure, with a maximum height of 306 feet above foundation level and 206 feet above the stream bed, a maximum base width of 154 feet and a top length of

1,274 feet. Its masonry volume is 550,000 cubic yards. The spillway is a separate structure adjoining one end of the dam. It creates the largest existing artificial irrigation reservoir in the world, its capacity being 115 billion cubic feet.

ELEPHANT HEADS (*Pedicularis grœnlandica*), a small perennial herb of the figwort family. It is native to wet meadows from Labrador and Greenland west to British Columbia, and southward to the mountains of New Mexico and California. The stem, about a foot high, bears smooth, deeply cut foliage and a dense cluster of crimson flowers, each with a long extended, curved lip, in shape strongly resembling an elephant's head.

ELEPHANTIASIS, a condition characterized by enlargement of the skin and tissues under the skin, due to blocking of the lymph channels. The legs and the scrotum are the parts most often affected. The disorder is most often due to infestation with filaria, parasitic organisms, the commonest filaria of man being *Filaria bancrofti*. The disease is quite common in many tropical countries, but occurs rarely in the southern part of the United States.

The onset of the swelling may be painless and slow or sudden, accompanied by fever, rapid swelling and redness. There may be a series of such attacks, each one worse than before.

Another type not caused by parasites, may arise without any obvious cause or follow inflammation of the skin, or after removal of the lymph glands. The legs are most frequently involved, beginning usually in one leg, about the foot or ankle, and extending until the whole leg is affected. The skin is generally smooth but it may become thick and hard, often fissured or nodular.

In elephantiasis of the parasitic type, during periods when the symptoms are acute the patient should rest and the legs be firmly bandaged. Fibrolysin has been used with good results. Surgical measures may be advisable. No treatment of any value is known for the non-parasitic type. See also ENTOMOLOGY, MEDICAL: Disease Breeders. W. I. F.

ELEPHANT SEAL (*Mirounga angustirostris*), the largest of the true, or earless, seals, old bulls reaching a length of 20 or more ft. The peculiar proboscis-like muzzle of the male hangs flaccid when the animal rests, but is inflated during excitement. Elephant seals, which are clumsy on land owing to their great mass, use their fore-flippers, as do sea-lions, to assist locomotion. At the beginning of the 19th century immense herds of these huge seals frequented the California coast, the roar of their battles during the breeding season being audible for miles. Another species was plentiful in the South Seas. So ruthlessly, however, have they been slaughtered for their valuable hides and oil that the northern species is practically extinct, while the southern is making its last stand.

ELEUTHERA, an island of the West Indies, one of the group of 20 islands and rocks known as the British Bahamas, all lying off the southeastern coast

of Florida. They form an administrative unit with NASSAU, in New Providence Island, as the capital. Eleuthera lies about 50 mi. north of New Providence and is separated from Abaco by New Providence Channel. It has an area of 235 sq. mi. Its soil is very productive and heavily timbered. Tomatoes, lumber, sponges and shells are the chief commercial products. The largest settlement is The Bluff. Pop. 1931, 6,168.

ELEUTHERIUS, ST. (175-189), bishop or pope of Rome in the 2nd century, was probably born at Nicopolis, Greece, but nothing is known of his early life. He is chiefly remembered for his opposition to Montanism, a heresy which, originating in Asia Minor, spread to Rome and Gaul. His pronouncement against it was aroused by a letter from Irenæus, later bishop of Lyons. He died on May 24, 189, and was buried on Vatican Hill, near the body of St. Peter.

ELEVATORS, a term confined to devices for raising and lowering passengers or materials within a confined space, usually known as the elevator well, or shaft. In most cases the elevator shaft is enclosed so as to be as nearly fireproof as possible and to prevent its acting as a means of communicating fire from one floor to another. The elevator cage is guided between vertical rails and usually equipped with devices which grip these rails should the elevator drop, or exceed a predetermined speed in descent. Present day elevators are nearly all electric, of the traction type with the motors at the top. Wire cables are used for hoisting. The plunger elevator, which was in vogue ten or more years ago, was made obsolete by the increasing heights of the modern building. Automatic elevators, in which the passenger controls the starting and stopping of the car by buttons, either in the car or at each floor, are growing in favor. Many large buildings also have automatic control by the operator, who pushes a button for each floor at which passengers wish to stop. Passenger elevator speeds have increased rapidly until 1000 feet per minute is in use in some places. The size of elevators for freight have also increased, large auto trucks now being carried. In the recently developed automatic elevator for garage use, the operator at the bottom controls not only the hoisting of the car to the desired floor but the movement of a small truck or "dolly" that comes to the elevator, pulls the car off and parks it in its proper place. Reversing the process enables the same dolly to select the proper car and place it on the elevator.

The term, elevators, is also used referring to continuous moving troughs, used for elevating mill products from one machine to another. Chain-and-bucket elevators have one or two strands of chain with outstanding buckets. In belt-and-bucket conveyors, the belts are of canvas or rubber and have buckets attached. The endless chains or belts travel over two sprockets or rollers. The buckets become loaded when turning under the lower, and discharge when turning over the upper.

ELGAR, SIR EDWARD WILLIAM (1857-), English music composer, was born in Broadheath,

June 2, 1857. He succeeded his father as organist at St. George's, Worcester, in 1885, previously having been conductor of the Worcester Amateur Instrumental Society. In 1889 he moved to London, later settling in Malverne to devote himself to composition. His chief works are two symphonies, the four oratorios, *The Light of Life*, *The Dream of Gerontius*, *The Apostles*, and *The Kingdom*, a military march, *Pomp and Circumstance*, and a set of orchestral variations, entitled *Enigma*. He was the recipient of numerous honorary degrees, and was knighted in 1904, in 1911 receiving the Order of Merit, and in 1924 obtaining an appointment as Master of the King's Music.

ELGIN, THOMAS BRUCE, Seventh Earl of (1766-1841), British diplomat, was born July 20, 1766. He was educated at Harrow, Westminster and St. Andrews, and studied international law at Paris and military science in Germany. Entering the army, he rose to the rank of general, but his particular interest was diplomacy, and he filled important posts at Brussels and Berlin, and at Constantinople (1799-1802). In 1801, with permission of the Ottoman government, he caused the removal of the frieze of the Parthenon, one of the Karyatides from the Erechtheum and other sculptures from the Acropolis at Athens, since called the Elgin Marbles. His act raised a storm of protest and drew upon him the charge of vandalism, but he defended his course and the sculptures were later purchased by England (1816) and are now in the British Museum. Lord Elgin died at Paris, Nov. 14, 1841.

ELGIN, a city of Kane and Cook counties, Ill., on the Fox River, 37 mi. northwest of Chicago. It has adequate transportation facilities by the main division of three railroads and an outer belt line which is a direct hook-up with interstate freight lines. Elgin is a market for the extensive dairying interests of the tributary country and has substantial manufactures of butter, butter tubs and dairy supplies. The Elgin watch plant and a concern publishing church and Sunday-school literature are among the major establishments. In 1929 the value of the factory output was about \$32,000,000; the retail trade amounted to \$23,853,248. A state asylum for the insane, Elgin Academy, a museum, and a zoological garden, are located in the city. James J. Gifford, the first settler, platted the original hamlet in 1842 and named it after a Scotch song entitled "Elgin." It became a city in 1854. Pop. 1920, 27,454; 1930, 35,929.

ELGIN MARBLES, a priceless collection of masterpieces of Greek sculpture, brought from Athens to England about 1812 by the Earl of Elgin for the British Museum. They include most of the surviving sculptures of the Parthenon, and blocks from the Erechtheum of Athens and the Mausoleum of Halicarnassus. The removal was with the permission of the Turkish Government, which then held the Greek city in subjection.

ELI, in Biblical account, a Hebrew judge who had been a priest of a temple at Shileh, in the southern

part of the territory occupied by the tribe of Ephraim. His influence spread to other tribes because of his long and pious life. On hearing the news that his sons had been slain and the ark lost in battle with the Philistines, Eli is reported to have fallen dead.

ELIJAH, one of the greatest of the Hebrew prophets. He flourished in the 9th century B.C., in the reign of Ahab, King of Israel. The sources of knowledge of him are in I Kings 17-21; II Kings 1-9 and II Chronicles 21: 12-15, where mention is made of his appearances before Ahab to protest his honor of the pagan gods of his wife Jezebel. Elijah predicted a great drought, and was compelled to flee from Ahab. In his exile he is said to have been fed miraculously by ravens and also by the widow of Zarephath, whose dead son he restored to life. The most dramatic event in the narratives is his successful conflict with the priests of Baal, which led Ahab to order their destruction and ended the drought. Of Elijah's death the Bible records that he was caught up in a chariot of fire to heaven. Many believe him to have been the first great ethical prophet of the Hebrews, whose life has been idealized with legends. In Moslem legends Elijah is el-Hadir, the guardian of the seas. The drought is attested by Menander of Ephesus, who says that it was stayed by a procession of Phoenician priests.

ELIJAH VILNA or **ELIJAH BEN SOLOMON** (1720-97), famous rabbinical scholar and opponent of Hasidism, was born at Selz, Lithuania, in 1720, and died in 1797 at Vilna, Poland, where he spent the greater part of his life. Far more liberal in his religious views than the majority of his contemporaries, and a bitter opponent of the casuistic methods employed by the Polish Jews, he was greatly venerated by Lithuanian Jewry for his pure character, sterling talents and rigid piety. Indeed, the people of those times, believing that he was bringing back the greatness of the period of the Geonim, or heads of the Jewish academies, of Babylonia, called him the "Vilna Gaon," a name by which he was commonly known.

A strict observer of the Jewish ritual law, Elijah Vilna opposed the Hasidim mainly because of their rejection of many of these laws and rites. In his hatred of the Hasidim he even went so far as to forbid intermarriage with them. His learning was prodigious. He was well-versed in Bible and Halacha (law), mathematics, astronomy, Hebrew grammar, anatomy, history and medicine, and was active as a critic of and commentator on the various Talmudic and rabbinical writings. His works display this great scholastic versatility, including comments on the Bible, Mishna, Talmud, Tosefta, Shulhan Aruch, Midrash, and on various Cabalistic works and works of MOSES MAIMONIDES and ASHER BEN JEHIEL; also essays and books on Biblical geography, archaeology, astronomy, chronology, trigonometry and other subjects.

A. SH.

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ELIMINATOR, BATTERY, a device for converting power from an ALTERNATING-CURRENT source into power at such direct currents and voltages as may be required for the Plate and GRID circuits of electronic tubes (see TUBES, ELECTRONIC). In other words, it is a device to replace the "B" and "C" batteries in a RADIO RECEIVER by utilizing an ordinary alternating current power supply.

Such an eliminator consists essentially of a TRANSFORMER to "step up" the voltage of the source, a RECTIFIER to obtain pulsating, but unidirectional, current and a FILTER to smooth out the pulsations, i.e., to provide a steady supply of direct current. The device may also include a network of resistors, so that different voltages are available for the various parts of the radio receiver.

ELINVAR. See NICKEL STEEL.

ELIOT, CHARLES WILLIAM (1834-1926), American educator, was born in Boston, Mar. 20, 1834, and died at Northeast Harbor, Me., Aug. 22, 1926. He was descended from a distinguished colonial family, his father, Samuel Atkins Eliot, being a prosperous merchant until his failure during the depression of 1857. The son was educated at the Boston Latin School and Harvard College, graduating in 1853. The next year he was appointed tutor in mathematics, and from 1858-63 was assistant professor of mathematics and chemistry. After two years in Europe studying chemistry and pedagogy, he became professor of chemistry in the Massachusetts Institute of Technology, and in 1869 he was appointed President of Harvard University.

During the 40 years of his presidency, Eliot transformed the institution from a provincial college with a few professional schools into a great university. His policy as an educator was determined by his belief in liberty. He extended to its logical limit the system of free election of studies by the student, a system which had been to a considerable degree already introduced at Harvard, and he sought to develop character by placing on the individual responsibility for his own habits and conduct. Thus Harvard College became an institution for the intellectual development of young men. The Medical School, after many years of persistent effort, has taken its place in the front rank. To the Law School he appointed as dean C. C. Langdell, and supported him in the introduction of the "case system" of studying law and in other constructive reforms which resulted in the position of leadership which it still enjoys. The Divinity School was reorganized and put on a basis of sound scholarship; a Graduate School of Arts and Sciences was founded in 1890; of Applied Science in 1906; and of Business Administration in 1908. Other departments of research and professional training were added from time to time, the endowment and equipment vastly increased, and a large number of brilliant scholars enrolled on the faculties. When he retired in 1909, he was beyond comparison the man of greatest achievement and widest influence in education in America.

During the latter part of his academic career he had played an increasingly important part in public affairs, and his retirement gave him a still greater prominence. In his last year at Harvard he undertook the editorship of the Harvard Classics, a set of 50 volumes of the literature of the world which still has an immense circulation. In 1911 he went round the world on a mission sponsored by the Carnegie Endowment for International Peace, and the report which resulted was only one of a number of publications devoted to the cause of good will among nations. He was a strong supporter of Civil Service Reform. In industry he believed in collective bargaining, but his allegiance to liberty led him to oppose the closed shop and to both capital and labor he played the part of the candid friend.

In religion he was by inheritance and conviction a Unitarian, his mature views being summed up in *The Religion of the Future*. He spoke and published much on the conduct of life, some of his more important volumes being *The Happy Life*, *John Gilley*, *Maine Farmer and Fisherman*, *Four American Leaders* (Franklin, Washington, Channing, Emerson), and *The Durable Satisfaction of Life*. Many of his books are reprints of addresses. He was an impressive public speaker with a rich, vibrant voice, great dignity of bearing, and a style severely simple, but forcible and telling. As an administrator he was far-sighted, courageous, patient and just. He had a reputation for austerity, yet in intimate circles was capable of gaiety. In 1858 he married Ellen Derby Peabody (d. 1869) and in 1877 Grace Mellen Hopkinson. His two sons were Charles Eliot, the distinguished landscape architect (d. 1897), and the Rev. Samuel Atkins Eliot, who survived him. Dr. Eliot died at Northeast Harbor, Me., at the age of 92. W. A. N.

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ELIOT, GEORGE (1819-80), pen name of Mary Ann (or, as she later preferred to write it, Marian) Evans, English novelist, who was born Nov. 22, 1819, in the parish of Calton, Warwickshire. Her father, a land-agent at Newdigate, took great pride in his daughter's intelligence and educated her well. The atmosphere of the Eliots' home was strongly religious, and Mary Ann followed orthodox Methodism till she was past her girlhood. Then she met the free-thinker Charles Bray, even living in the Brays' home after her father's death in 1849, and swung so far away from her early training as to finish the half-translated *Life of Jesus*, by Strauss, as her first important work. She seemed for some time to be in a fair way to spend her life in the translation of similar books, and in literary criticism. In 1851 she was offered the assistant editorship of the *Westminster Review*, and threw herself into the exacting work wholeheartedly. But in 1853 it was her good fortune to meet GEORGE HENRY LEWES, the editor of the *Leader*, who was the first to suspect that her real field was the writing of

fiction. Lewes's wife was in an asylum, and under the laws of England it was impossible for him to be legally free from her. The year after meeting with George Eliot the two openly took up residence with each other, and from then until Lewes's death in 1878 they were seldom separated. Encouraged by him, George Eliot turned to fiction and, under her pseudonym, sent *Amos Barton*, the first of her stories, to *Blackwell's Magazine*, which accepted and published it without the slightest suspicion that its new contributor was a woman. In 1858 this story and two others appeared in book form as *Sketches of Clerical Life*. In 1859 ADAM BEDE, George Eliot's first novel, appeared, and from that day she was dedicated to her career as a novelist. *The Mill on the Floss*, 1860, followed it; it is her acknowledged masterpiece, and its early chapters are to all intents the autobiography of her childhood. SILAS MARNER appeared in the same year, and shortly after George Eliot went to Italy to gather the material for *Romola*, 1862. *Middlemarch*, 1872, shows great maturity and power but her later novels, including *Daniel Deronda*, 1874, and *Theophrastus Such*, 1878, were too heavily dogmatic to suit popular taste. In 1878 Lewes died. Two years later, when she was 61, George Eliot married John Walter Cross, a man much her junior, who had long been her warm advocate and admirer. She died in London, Dec. 22, 1880. See also ENGLISH LITERATURE.

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ELIOT, JOHN (1604-90), American colonial clergyman, was born probably at Wedford, England, in 1604. He was graduated in 1622 at Jesus College, Cambridge, and after being ordained in the Church of England he went to America in 1631 and settled in Roxbury, Mass., where he studied Indian dialects and in 1646 began to preach to the Indians. His success prompted England to support his endeavor and by 1674 he had converted 4,000 "praying Indians" who were organized into colonies. He translated the Bible into the Indian tongue and helped prepare *The Bay Psalm Book*, the first book printed in New England. Eliot died at Roxbury, May 21, 1690.

ELIOT, THOMAS STEARNS (1888-), editor, poet and critic, was born in 1888 at St. Louis, Mo. He was educated at Harvard, at the Sorbonne, and at Merton College, Oxford, and devoted himself to journalism and literature, becoming editor of *The Criterion*. Eliot ranks as one of the leading modern poets, being noted especially for his *Waste Land*, which was awarded the Dial Prize for 1922. As a critic he is a staunch classicist. Among his works are *The Sacred Wood*, 1920, *Homage to John Dryden*, 1909-25, *An Essay of Poetic Drama*, *Shakespeare and the Stoicism of Seneca*, *For Lancelot Andrewes*, 1928, *Dante*, *Ash Wednesday*, 1930, and *Thoughts After Lambeth*, 1931.

ELISHA, a Hebrew prophet, attendant and successor of Elijah, was the son of Shaphat and belonged to Abel-meholah, where Elijah found him ploughing with oxen. He gave heed to the call of Elijah, bade his family farewell, and slew his oxen for a sacrificial feast for the people about him. For about 50 years Elisha aided the kingdom of Israel in its struggle for national independence. The narratives of his life in the Bible show, according to some scholars, that like his predecessor Elijah his actions were idealized, so that many legends grew around his name. Some of the miracles attributed to him were in appearance cruel and stern, as for instance his cursing of the youths of Bethel who mocked him, so that two she-bears came and devoured 42 of their number, and also his punishing Gehazi with lifelong leprosy for covetousness. Elisha's service to his nation was appraised at his death by Joash as equal in worth to the aid of an army, according to the famous exclamation: "My father! my father! The chariots of Israel and the horsemen thereof!"

ELISHA BEN ABUYAH (1st and 2nd cent.), prominent Tanna (Jewish teacher of the Mishna) and rabbi at the end of the 1st century and of the first four decades of the 2nd century A.D. In his later years he became an apostate from Judaism. Originally renowned as one of the greatest authorities on Jewish religious law, he subsequently became a free-thinker, and broke away from Jewish studies and from his former colleagues and associates. The cause of his apostasy from Judaism was his mystical and Gnostic speculations and studies.

Several of Elisha ben Abuyah's pedagogical dicta, which are of great import, are preserved in *Aboth* 4:25 and *Aboth de Rabbi Nathan* 25; especially his prime maxim that he who does good deeds and has learned much is like one who lays both a firm foundation and a stout upper structure of his house. The most important things in life, more important than studies, are good deeds and upright conduct. All these maxims are the product of his earlier, happier years as a Tanna. However, after his apostasy from Judaism, he tried to destroy the Jewish Law, which he had grown to despise, showing his malice toward Judaism in various ways, and persecuting its adherents.

BIBLIOGRAPHY.—Jellinek, *Elischa ben Abuya*, 1847; S. Baek, *Elischa ben Abuja-Acher*, 1891; Bacher, *Agada der Tannaiten*, vol. 1, pp. 432-36; Graetz, *History of the Jews*, 1926.

ELISIRE D'AMORE, L', an opera in two acts by GAETANO DONIZETTI, libretto by Felice Romani; premiere, Milan, 1832, London, 1836, New Orleans, 1842, New York, 1883. It is one of the more popular of Donizetti's many operas and has become part of the standard repertory in all countries under its Italian title, *L'Elisire d'Amore*.

Hopelessly smitten by the haughty and wealthy Adina, Nemorino woos her unsuccessfully. She laughs at his uncouthness and seems to be taken with a new arrival in the village, Sergeant Belcore. Driven to despair, her awkward suitor decides to purchase a

love potion from a traveling quack, Dr. Dulcamara. This he drinks down with gusto, never suspecting that it is simply cheap Bordeaux wine. However, under its influence Nemorino feels so gay that he ceases to despair over the fair Adina, and she, piqued by this change of front, retaliates by becoming engaged to Sergeant Belcore. Apparently the first draught was unsuccessful, the peasant boy thinks, so he now purchases a second with the money he receives for enlisting in Belcore's battalion. This he drinks, becoming even more jovial than he was before. Ignorant of the fact that his rich uncle has made Nemorino his heir, he finds himself surrounded by all the girls in the village who have gathered the news ahead of him. The efficacy of the love potion is thus established, Dr. Dulcamara reaps a fortune, and the formerly haughty Adina falls into the arms of her uncouth suitor.

ELISSA. See *DIDO*.

ELIXIR OF LIFE, a substance such as a stone, liquid or powder which according to the theories and practice of *ALCHEMY* would, if absorbed by the human body, maintain life or restore youth. It is variously and fancifully described by medieval and later writers, and its formula and properties described in magical or mystical terms. It formed a central quest in *OCCULT* lore. Proofs were at times offered in persons apparently youthful claiming many scores of years.

ELIZABETH, ST. (1207-31), also known as St. Elizabeth of Thuringia, was born probably at Pressburg, Hungary, in 1207, the daughter of King Andrew II of Hungary. Her maternal aunt was St. Hedwig of Silesia, and her great-niece was St. Elizabeth of Portugal. From childhood she was reared at the Thuringian court with her future husband, Ludwig, landgrave of Thuringia, whom she married when she was but 14. When he died in 1227, she devoted her life to helping the Franciscans, building their hospital at Marburg in which she ministered to the sick and the dying. She died at Marburg, Germany, Nov. 17, 1231.

ELIZABETH (1533-1603), Queen of England, was born in Greenwich Palace, Greenwich, London, Sept. 7, 1533, the daughter of *HENRY VIII* and *ANNE BOLEYN*. Her mother was beheaded for treason on Apr. 19, 1536, and on July 1 of the same year Parliament declared that Elizabeth and her half-sister, *MARY*, 17 years her senior, were both illegitimate; but later they were placed in the order of succession to the throne. Elizabeth was a few weeks over 25 years of age when on Mary's death, Nov. 17, 1558, she became Queen by act of Parliament and the will of the people. She had been well and carefully educated; she was an accomplished linguist and a proficient musician; yet she seems to have had little interest in learning and to have stood apart from the literary and intellectual outburst that is associated with her reign. From her mother, Elizabeth inherited her vanity and frivolity; but she resembled her father yet more. Elizabeth's vigor and force of will,

her natural aptitude for politics, she derived from *Henry VIII*; she was also like him in her ability to choose and to use wise counsellors, and intuitively to sense the needs and desires of her people. During Mary's reign, 1553-58, Elizabeth had lived in constant danger, suspected of complicity in plots and intrigues; and her early experience increased at once her self-reliance and her natural powers of dissimulation.

What policies the new Queen would follow in dealing with the problems that confronted her at the outset of her reign, none knew, possibly not even Elizabeth herself; but she played her cards with caution and displayed such shrewdness and finesse in the exercise of power as to make it evident that she was a master of statecraft. Within a few months she brought to an end the ruinous war with France; and common sense triumphed over national pride when, in return for a money indemnity, she left Calais in French hands. "Put money in thy purse" was advice that Elizabeth was always glad to follow; she had more than a touch of the niggardliness that had characterized her grandfather, *HENRY VII*. Sound financial policy dictated rigorous economy in Governmental expenditures, for the country was on the brink of insolvency. Elizabeth showed courage as well as wisdom, when, within two years of her accession, she recalled the debased coinage from which *Henry VIII* and *EDWARD VI* had made a fraudulent profit and issued new coins of full face value. This went far toward restoring the confidence necessary for trade and made it possible for the Government to borrow money at lower rates than could other states.

Both conservatives and the reform party were disappointed in Elizabeth's ecclesiastical policy, which was shaped by political expediency rather than by religious considerations. The papal jurisdiction, restored in the preceding reign, was again abolished; not because the papal court considered Elizabeth illegitimate, for the same decision had been reached by an English court and by Parliament, but because the establishment of papal authority had been found to be one of Mary's chief blunders and because the new Queen could brook no superior. But there was no active persecution of Roman Catholics until the papal bull of 1570 which excommunicated the Queen and declared her subjects absolved from their allegiance made it almost impossible for an Englishman to be at once a loyal subject and a Roman Catholic. On the other hand, those who hoped for alterations more drastic than those of *Edward VI* were disturbed by Elizabeth's conservatism, by the crucifix and lights in her chapel, by her unwillingness to have the Church of England approximate the reformed churches on the continent. "Mere English," was Elizabeth's proud description of herself; and it comes very close to being a description of her religious settlement, unlike either the Catholicism or the Protestantism of the continent.

Elizabeth's vacillation and her love of intrigue for

own sake had complicated the labyrinthine maze her foreign policy. Conscious that it was to her vantage for France and Spain to continue to be als, she played one against the other with considerable dexterity. She maintained friendly relations with Philip in Europe while she profited from : war her subjects waged against him on the seas d in his colonies; she connived unofficially at the instance given to Netherlanders and to Huguenots, t she would not openly countenance rebellion nor ampion foreign Protestantism. Her unmarried state is a valuable asset, because for years at a time she could ld out the prospect of a matrimonial alliance, the vile she indulged in diplomatic and other flirtations. hen at last the war with Spain came and the eat ARMADA set sail, it was due rather to the temst and to the stout courage of English mariners in to any activity or foresight of Elizabeth's that ilip's supreme effort was foiled. Elizabeth's record at its worst in her dealings with Mary, Queen of ots (*see* MARY STUART). Mary's long detention in gland may be justified by considering the perils that y other course would have entailed; when the Eng-h ministers insisted that she be put to death, Eliza-h shrank from signing the warrant, but endeavored successfully to have Mary murdered.

In her dealings with parliament, Elizabeth showed : qualities of her father: an imperious will coupled th a self-restraint that made her willing to com-mise rather than to force an issue. At times cruel d merciless, Elizabeth yet seems to have aimed iefly at holding the admiration and support of her ojects. With favored courtiers the Queen indulged familiarities that showed an utter lack of delicacy; : was unduly fond of adulation, and so jealous as resent bitterly the marriage of any of her favorites. ve for her cry when word reached her of the birth Mary Stuart's son, there are few feminine touches the story of Elizabeth. The brilliant success of r Government, which was partly though not wholly r achievement, placed Elizabeth among the greatest English sovereigns. The last 15 years of the reign re a period of decline, and Elizabeth left grave oblems to her successor. She died at Richmond, ar. 24, 1603. *See also* ENGLAND, HISTORY OF; ESSEX.

A. H. S.

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ELIZABETH, an industrial city and the county it of Union Co., N.J., located on Newark Bay and thur Kill, 11 mi. southwest of New York City and joining Newark on the south. It is connected with yonne and Staten Island by railroad bridges; and : Goethals' bridge, one of the longest cantilevers the world, is an important link of the highway item between New Jersey and New York. It is ved by the Pennsylvania, Baltimore and Ohio, ading, Lehigh Valley, and Central of New Jersey

railroads the latter having extensive shops located here, and by bus lines and an airport. Among its many and varied industries, the products of which were valued at \$116,166,300 in 1930 are printing, ship-building, and the manufacturing of sewing machines, beds, mattresses, cable, tools, dry ice, clothing, asbestos products and steel and petroleum products. In 1929 the manufactures reached approximately \$122,000,000; the retail trade amounted to \$62,701,110, and the wholesale trade proper, to \$21,011,988. One of the early industrial centers of the country, it was incorporated as a borough in 1709 and it was the scene of fighting during the Revolution. Among its prominent residents have been numbered Abraham Clark (signer of the Declaration of Independence), GEN. WINFIELD SCOTT, AARON BURR and ALEXANDER HAMILTON. It was granted its charter as a city in 1855. Pop. 1920, 95,783; 1930, 114,589.

ELIZABETHAN ERA, the Renaissance period in English literature, contemporary with the reign of QUEEN ELIZABETH (1558-1603), when all forces—cultural, religious and political—united to produce a Golden Age in lyric poetry and the drama. The influence of the classics, which were then for the first time made available in English translations, was incalculable. But hardly less great was the general atmosphere of the age, when ideas were exciting in themselves, when talk and wine ran equally freely in taverns, when the "natural man" enjoyed pleasure without an after-thought for damnation, and when a poet brought words together into a line of poetry without much care for the line's ultimate significance but with the utmost care for its beauty. It was not an age of prose, though it produced the excellent writings of Francis Bacon, North, Holinshed and Lyly. Poetry was its natural expression, either in the form of the lyric or in the blank verse of the drama. The lyricists included Sir Philip Sidney, Daniel, Drayton, Heywood, Campion, Nashe, Lodge and a host of others. Edmund Spenser helped to discipline verse, and the recently imported sonnet was in itself a severe discipline for poets. The drama, flourishing in the theaters of the Bankside, was written almost exclusively in blank verse. The most notable dramatists of the age were Lyly, Peele, Greene, Marlowe, Heywood, Dekker, Chapman, Greene, Christopher Marlowe, Ben Jonson, and, lord of all, Shakespeare. Beaumont and Fletcher, Middleton, Webster, Massinger, Ford and Shirley, though almost all their work was produced after the death of Elizabeth, are usually included in the history of Elizabethan drama. *See also* ENGLISH LITERATURE; ENGLISH DRAMA; separate articles on the above authors.

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ELIZABETHAN DRAMA. *See* PRE-SHAKESPEAREAN AND SHAKESPEAREAN DRAMA.

ELIZABETHAN STYLE, the term applied to the development of English architecture from the late

Gothic into the early Renaissance period. It was a style generally covering the reign of Queen Elizabeth (1558-1603), and its principal monuments were the great manor houses erected in many parts of England at that time. The Elizabethan country house is distinguished by its union of Gothic and Renaissance features. The general outline remains Gothic, but classic details are used in ornamentation. One marked feature is the increase of window space; but the windows remain mullioned and transomed. Frequently a house is built in general conformity with late Gothic principles on the outside, while the interior is decorated with classic detail.

Some Flemish and German, as well as considerable Italian, influence are seen; but in the main the building is quite definitely English. The half-timber work which became popular in the Tudor period increased in favor, although much building was also done in brick and stone. Walls are generally paneled in wood from floor to ceiling. Fireplaces are very rich, and sometimes heavily over-decorated. Ceilings have decorative plaster work, and staircases are frequently elaborately carved. Another feature of the Elizabethan house, as distinct from earlier domestic building, is its outstanding comfort. With the coming of peaceful times, men built houses, not to defend, but to live in. For bibliography see RENAISSANCE ARCHITECTURE.

ELIZABETH CITY, a city and county seat of Pasquotank Co. in northeastern North Carolina, situated on the Pasquotank River, 48 mi. southeast of Norfolk, Va. Elizabeth City is a seaplane port, riverport and served by several steamship lines, bus lines, and the Norfolk Southern Railroad. Cotton, truck-garden produce and potatoes are the chief crops of the vicinity. Lumber and textiles are the important manufactures. In 1929 the value of the factory output was about \$1,000,000; the retail trade amounted to \$6,488,477. The city is surrounded by many places of historical interest; Old Fort Raleigh and the site of Culpepper's Rebellion are near by. The city was incorporated in 1795. Pop. 1920, 8,925; 1930, 10,037.

ELIZABETHPOL. See GANDZHA.

ELIZABETHTON, a city in northeastern Tennessee, the county seat of Carter Co., situated at the confluence of the Watauga and the Doe rivers, 20 mi. south of Bristol. Bus lines and two railroads serve the city. This region in the picturesque Appalachian Mountains has coal, manganese, lead, zinc, ochre, fine marbles and many other minerals. There are great hydroelectric power plants for the mills which produce chiefly rayon and furniture. Elizabethton was settled in 1760 and became a city in 1905. During the Revolution the American forces, drilled here, were engaged in the BATTLE OF KINGS MOUNTAIN. ANDREW JOHNSON, seventeenth president of the United States, died near Elizabethton. Pop. 1920, 2,749; 1930, 8,093.

ELIZAVETGRAD. See ZINOVIEVSK.

ELK, a large, flat-horned deer (*Alces machlis*) of circum-polar distribution; a moose. It is the largest of the deer tribe and unlike the ordinary type in its bulky form, long legs, thick, flexible muzzle and

upper lip, and the great spread and weight of the buck's palmated antlers. These are good weapons against wolves. Elk are still to be found in the forests of subarctic Europe and Asia, where they subsist by browsing leaves and twigs, especially numerous where water is plentiful. When beset by deep snow, a band will collect, and together keep clear of snow a space, a "yard," in which they can rest and feed until released. As hunting them is restricted by law, some of these great deer will probably long survive in Lapland and eastward, as will the moose in Canada. The name elk was long ago mistakenly applied in the United States to a very different type of deer, the WAPITI.

ELK CITY, a city in Beckham Co., western Oklahoma, situated about 53 mi. north of Altus, Mo. Two railroads afford transportation. The city lies in a fertile farming and stock-raising district. The chief local manufactures are brooms, flour and cottonseed oil. The city has also cotton gins and cotton cleaners, a creamery and a bottling plant. Pop. 1920, 2,814; 1930, 5,666.

ELKHART, a city in northern Indiana, at the junction of the St. Joseph and Elkhart rivers, 16 mi. east of South Bend. It is served by Federal and state highways and by the New York Central Railroad lines. Elkhart is an industrial city, situated in a rich agricultural region, supplying fruits, cereals and dairy products. Its varied industries include the manufacture of band instruments, machinery, railroad and auto equipment and cardboard. In 1929 the manufactures reached approximately \$31,000,000; the retail trade amounted to \$17,114,223. The city was founded in 1832, and incorporated in 1858. Pop. 1920, 24,277; 1930, 32,949.

ELKINS, a city in central West Virginia, the county seat of Randolph Co., on the Tygart Valley River, 35 mi. southeast of Clarksburg. Two railroads afford transportation. There is an airport. Elkins is surrounded by a coal-mining and lumbering region. Grain, potatoes and hogs are the chief crops in this vicinity. The principal industries are lumber milling and leather manufacture. The city is the seat of Davis and Elkins College. Senator Stephen B. Elkins and Henry G. Davis founded the city in 1889; it was chartered the same year. The State Children's Home and State Odd Fellows Home are located here. Elkins is on the edge of the Monongahela National Forest. Pop. 1920, 6,788; 1930, 7,345.

ELKINS ACT, 1903, a supplement to the INTERSTATE COMMERCE ACT of 1887, designed to give the INTERSTATE COMMERCE COMMISSION power to enforce the provision against the granting of rebates by railways to consigners. The Elkins Act, the passage of which was urged by President Roosevelt, made the railway corporation itself liable to prosecution in all cases involving infraction of the anti-rebate and anti-discrimination clauses, whereas only its officers and agents were liable under the original law, and imposed penalties for the receiving as well as the granting of a rebate.

ELK KELP (*Pelagophycus porra*), a giant brown seaweed found along the shores of California from Point Concepcion southward. With the bladder kelp it forms in waters, down to a depth of 12 fathoms, submarine groves many miles in length. From a branching holdfast on the sea bottom arises a stout stem which is solid to about its middle. Here it broadens into a hollow portion that finally expands into a large hollow bulb, beyond which are branches bearing the leaves.

ELKO, a town in northeastern Nevada, the county seat of Elko Co. It is situated on the Humboldt River, 300 mi. east of Reno, Nev. and served by two railroads and by bus lines. Elko is a trade center in a cattle- and sheep-raising and gold- and silver-mining region. The town was founded in 1867. The surrounding country has picturesque mountains, hot springs and caves. Pop. 1920, 2,173; 1930, 3,217.

ELKS, THE BENEVOLENT AND PROTECTIVE ORDER OF. The Benevolent and Protective Order of Elks was founded Feb. 16, 1868, with the formation of the New York, N.Y., Lodge. Following the establishment in 1871 of the Grand Lodge, which was empowered by the General Assembly of the State of New York to grant charters to subordinate lodges, such groups were organized in Philadelphia, San Francisco, Chicago and Cincinnati and admitted on equal footing with the mother lodge, in New York. By 1879 there were 12 subordinate lodges, with a total membership of 829. To-day there are in the neighborhood of 1,600 such lodges, with a membership of more than 700,000, and total assets of approximately \$100,000,000. The Order is non-sectarian; but membership is restricted to white American citizens over 21 years old and of acceptable character. The head of the Order, known as the Grand Exalted Ruler, is elected annually for a single term of one year, by the members of the Grand Lodge, which is made up of all former heads of local lodges, and is the legislative body of the Order. The Grand Exalted Ruler conducts the affairs of the Order as its executive head, aided by a group of officers, some elected, some appointed; by a Board of Grand Trustees; by a Grand Forum, which exercises final judicial powers; and by various committees and representatives.

The preamble to the constitution of the Order declares its purposes to be to "inculcate the principles of Charity, Justice, Brotherly Love and Fidelity; to promote the welfare and enhance the happiness of its members; to quicken the spirit of American patriotism; to cultivate good fellowship. . . ." During the year 1930-31 the subordinate lodges expended, in charitable, community welfare and patriotic activities, a sum exceeding \$2,500,000. As an assistance to lodges carrying on disinterested work of this character the Elks National Foundation was formed. This is a permanent fund, the interest from which is allocated by a Board of Trustees to help carry on, under local supervision, important welfare programs.

The Order has erected and maintains in Chicago an

Elks National Memorial Headquarters Building, valued at \$5,000,000, which serves as the central point for the transaction of official business. At Bedford, Va., is the Elks National Home, a residence maintained for aged and indigent members. An official journal, *The Elks Magazine*, containing news of Elk activities, fiction and articles of a general nature, is published monthly in New York.

ELL, a unit of linear measure of varying values, the English ell being equal to 45 in.; as a cloth measure, it equals five quarters of nine inches or four nails; it is almost obsolete. In general usage *ell* is applied to something resembling the letter "L" in shape.

ELLACHICK, the popular name for a species (*Chelopus marmoratus*) of terrapin found along the Pacific coast from southern Canada through California. It is about 7 or 8 in. long, and lives in rivers and ponds. The ellachick is the most valuable edible terrapin of the far west.

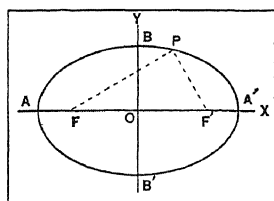
ELLIOT, DANIEL GIRAUD (1835-1915), American zoölogist, was born in New York City, March 7, 1835. After preliminary study, he traveled, from 1856 on, in Europe, Asia and America. For the Field Museum of Chicago, he led an expedition into East Africa in 1896, and in 1898, he was in charge of an expedition exploring the Olympic Mountains of Washington. Elliot was a Fellow of the Royal Society of Edinburgh, and received ten European decorations. His works include: *The Grouse*, *The Pheasants*, *North American Shore Birds*, *Birds of North America*, *Synopsis of the Mammals of North America and the Adjacent Seas*. He died in New York, Dec. 22, 1915.

ELLIOTT, EDWARD CHARLES (1874-), American educator, was born at Chicago, Ill., Dec. 21, 1874. He graduated from the University of Nebraska in 1895 and took his Ph.D. at Columbia in 1905. From 1905-16, he was at the University of Wisconsin as associate professor of education, professor, and director of the course for the training of teachers; and from 1916-22 was chancellor of the University of Montana. He became president of Purdue University in 1922. His publications include *State School Systems* and *City School Supervision*.

ELLIOTT, HOWARD (1860-1928), American railroad executive, was born in New York, Dec. 6, 1860. From a surveyor on the C. B. & Q. Railroad he rose to president of the Northern Pacific Railway. From 1913 to 1917 he was president of the New York, New Haven and Hartford Railway and chairman of its board of directors. Elliott was active in Congress in behalf of favorable legislation for the railroads and urging the creation of a department of transportation. Elliott served as a member of the board of overseers, Harvard University, 1909-22. He died July 8, 1928.

ELLIPSE, one of the three CONIC SECTIONS, in modern times considered as a curve instead of a surface. Its general equation in Cartesian coordinates is $x^2/a^2 + y^2/b^2 = 1$. In the figure, AA' is the major

axis and BB' is the minor axis. The points F and F' are the foci, and $OF = OF' = \sqrt{a^2 - b^2}$, where $a = AO$, and $b = BO$, the semi-axes. Taking e such that $ae = \sqrt{a^2 - b^2}$, we have $e = \sqrt{1 - b^2/a^2}$, known



ELLIPSE WITH FOCI F AND F'

as the eccentricity of the ellipse. It is a property of the ellipse that for any of its points P , $PF + F'P = 2a$. The area of an ellipse is πab .

ELLIPSOID, a closed surface of which every plane section through either axis is an ellipse. In case one of these ellipses is a circle, the figure is a spheroid. The Cartesian equation, the origin being at the center, is

$$\frac{x^2}{a^2} + \frac{y^2}{b^2} + \frac{z^2}{c^2} = 0.$$

See SOLIDS; PARABOLOID; HYPERBOLOID.

ELLIPTIC FUNCTIONS. From the point of view of the theory of functions of a complex variable, any problem of integration which involves only rational functions of the independent variable x , or of x and a single irrationality y of the form

$$y = \sqrt{a + bx + cx^2}$$

may be solved with the assistance of logarithmic and exponential functions or, if one prefers, with the assistance of the trigonometric and anti-trigonometric functions. An elliptic integral is the integral of a rational function of x and y where

$$y = \sqrt{a + bx + cx^2 + dx^3 + ex^4}$$

The French mathematician Legendre (1752-1833) spent many years in studying the properties and in calculating the values of elliptic integrals. Toward the end of his life, the German mathematician Jacobi (1804-51) and the Norwegian mathematician Abel (1802-29) were both inspired to reverse his line of thought. They considered the value of the integral as the independent variable and the variable of integration as the function. Starting from the integral

$$u = \int_0^x \frac{dx}{\sqrt{1-x^2} \sqrt{1-k^2x^2}}$$

Jacobi introduced elliptic functions which are now written thus

$$x = \operatorname{sn} u, \sqrt{1-x^2} = \operatorname{cn} u, \sqrt{1-k^2x^2} = \operatorname{dn} u.$$

According to another theory, of which Weierstrass (1815-97) was the author, the standard elliptic integral is

$$u = \int_x^\infty \frac{dx}{\sqrt{4x^3 - g_2x - g_3}},$$

and the corresponding elliptic functions are

$$x = p(u), \sqrt{4x^3 - g_2x - g_3} = p'(u).$$

The theory of elliptic functions may be regarded as an extension of trigonometry in which $\sin x$ is replaced by $\operatorname{sn} x$ and $\cos x$ by $\operatorname{cn} x$ and $\operatorname{dn} x$. The simple periodicity of the trigonometric functions is replaced by double periodicity of the elliptic functions. The elliptic functions have an addition theorem. Elliptic functions have many applications in mechanics and mathematical physics.

T. S. F.

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ELLIS, HENRY HAVELOCK (1859-), English psychologist and writer, was born in Surrey, Feb. 2, 1859. As the son and grandson of sea captains he traveled widely, spending much of his youth on the Pacific. He became a teacher in New South Wales, 1875-79, but returned to London to study medicine at St. Thomas's Hospital. He soon discarded the profession, however, for the career of scientist and writer, his interest being particularly in sex psychology. His books, which quite apart from their scientific value are delightful reading, include *Psychology of Sex*, 1898-1910, *The World of Dreams*, 1911, *The Dance of Life*, 1923, *Men and Women*, 1926, and *Marriage Today and Tomorrow*, 1929.

ELLIS ISLAND, an island in New York Bay, used as an immigration station by the Federal Government, which purchased the site from New York State in 1808. The present buildings, erected in 1897 after a severe fire, include the receiving and deporting stations, a hospital, jail for alien criminals and the offices of the U.S. Immigration Commissioner.

ELLWOOD CITY, a borough of Lawrence Co., western Pennsylvania, about 36 mi. northwest of Pittsburgh. It is served by the Baltimore and Ohio, the Buffalo, Rochester and Pittsburgh, the Pennsylvania and the Pittsburgh and Lake Erie railroads and an airport. Ellwood City is in a gas and coal region and is a manufacturing center producing chiefly iron, steel, pipe, wire, brass, bronze and brick. In 1929 the retail trade amounted to \$6,082,151. Its altitude of 1,200 ft. makes it a pleasant summer resort. Ellwood City was incorporated as a borough in 1892 and later adopted a city-manager plan. Pop. 1920, 8,958; 1930, 12,323; over 20% are foreign-born.

ELLSWORTH, OLIVER (1745-1807), American jurist, was born at Windsor, Conn., Apr. 29, 1745. He began law practice at Hartford, Conn., and in 1778 was a delegate to the Continental Congress. In 1787, as a member of the Federal Convention, he advocated the rights of the individual States, and in 1789 became chairman of the commission to organize the judiciary of the United States. He served as chief justice of the United States Supreme Court during 1796-99. He died at Windsor, Conn., Nov. 26, 1807.

ELM (*Ulmus*), an important group of trees comprising about 20 species widely distributed in north-temperate regions except western North America. In

the United States and Canada eastward of the Rocky Mountains six species are found. The most important is the American or white elm (*U. americana*), a magnificent forest tree, one of the finest for park and street planting, which sometimes grows 120 ft. high, with a basal diameter of 6 to 11 ft. It ranges from the Maritime Provinces of Canada to the eastern base of the Rockies and southward to the Gulf states. The red or slippery elm (*U. fulva*), a smaller tree of similar range, produces a valuable dark red wood and a mucilaginous bark used in medicine. The cork elm (*U. racemosa*), nearly as large as the white elm with corky-winged branchlets, found from Quebec to Wisconsin and southward, likewise produces valuable timber. The wahoo elm (*U. alata*), the cedar elm (*U. crassifolia*) and the southern red elm (*U. serotina*) are smaller trees found in the southern states. The total cut of elm lumber in the United States in 1930 amounted to 109,999,000 bd. ft. valued at the mill at \$3,321,969.80.

The English elm (*U. campestris*), the Scotch elm (*U. glabra*) and other Old World elms are planted as ornamental trees in the eastern United States.

ELMAN, MISCHA (1892-), Russian violinist, was born in Talnoie, Jan. 20, 1892. Showing signs of virtuosity at the age of 10, he studied with LEOPOLD AUER for two years, making his debut at St. Petersburg in 1904. In 1908 he toured in the United States, where he duplicated his foreign successes and was generally recognized as one of the great modern violinists. After touring the United States for twenty years he founded the Mischa Elman String Quartet, which won a high place among chamber music organizations. In 1925 he married Helen Frances Katten of San Francisco, Cal. He has composed songs and violin pieces.

ELMHURST, a residential city of Du Page Co., Ill., 16 mi. west of Chicago, located on four main railroads. The retail trade in 1929 amounted to \$5,584,063. Elmhurst College was established here in 1871. The city was incorporated in 1900. Pop. 1920, 4,594; 1930, 14,055.

ELMIRA, a city of southern New York, the county seat of Chemung Co., situated on the Chemung River about 100 mi. southeast of Rochester, 149 mi. southeast of Buffalo and 46 mi. south of Ithaca. The city is an important transportation center, being served by the Erie, Pennsylvania, Delaware, Lackawanna & Western and Lehigh Valley railroads, bus lines and an airport. Elmira is attractively located at an elevation of 857 ft. above sea level and has a fine park system and water supply. About 20 mi. distant is beautiful Watkins Glen. The Elmira College for Women, said to be the first collegiate institution to grant degrees to women, is located in the city. The Elmira Reformatory is a model state prison for first offenders. The extensive manufactures include fire-fighting apparatus, automobiles, automobile parts and accessories, cosmetics, bottles and silk and knitted goods; their estimated value in 1929 was \$31,000,000; the retail trade amounted to \$30,618,256.

The Battle of Newtown, in which Gen. John Sullivan routed the British and Indians, destroying the Iroquois confederacy, took place near the site of Elmira on Aug. 29, 1779. The town was first permanently settled about 1778 by Capt. John Hendy, was incorporated under the name of Newtown in 1815, reincorporated as Elmira in 1828 and in 1864 secured a city charter. A Federal prison encampment was located here during the Civil War. Pop. 1920, 45,393; 1930, 47,397.

ELMIRA COLLEGE, at Elmira, N.Y., a privately endowed and non-sectarian institution for women, was founded in 1851, and located at Auburn in 1852 as the Auburn Female University. In 1853 it was removed to Elmira and two years later was rechartered as the Elmira Female College. Its productive funds in 1931 were \$1,162,954. The library contains 34,000 volumes. In 1931-32 there were 509 students and a faculty of 59, headed by Pres. Frederick Lent.

EL MORRO, an enormous varicolored sandstone mesa in west central New Mexico. The rock is about 300 ft. high and is so fantastically eroded as to have the appearance of a huge castle. In prehistoric times, its summit was the site of Indian dwellings. It lay along the route of the Zuni-Acoma Trail, the first highway in New Mexico and was a regular camping place for Spanish padres and soldiers. There are over 50 inscriptions covering the period from 1606 to 1774 carved on the smooth walls of the rock by these early travellers, including five by early Spanish governors of New Mexico. The rock also bears hundreds of prehistoric Indian pictographs. The El Morro National Monument, first created Dec. 8, 1906 and enlarged to 240 acres in 1917, includes the rock and other ruins of archeological interest. It is easily reached by motor highway from Gallup, N.M.

ELMWOOD PARK, a suburban city of Cook Co., Ill., on the western outskirts of Chicago. A growing population is probably due to residential attractions. The city was incorporated in 1914 with a population of 575. Pop. 1920, 1,380; 1930, 11,270.

EL OBEID, Africa, the capital of the province of Kordofan in the Anglo-Egyptian Sudan. It is situated 2,000 ft. above sea level. Khartoum lies about 225 mi. to the northeast. The inhabitants of the town are chiefly Arabs and Nubians and carry on a fairly extensive trade in cattle, ivory, ostrich feathers and gum. Most of the houses are built of straw and resemble corn stacks. At one time El Obeid was a Mahdist stronghold and had a population of 30,000. Pop. 10,000.

ELOI or **ELIGIUS** (c. 588-659), a French bishop and philanthropist, was born at Cadillac near Limoges, about 588. He learned the goldsmith's trade and was coiner to Clotaire II, King of the Franks. Dagobert I made him his treasurer. Both these kings gave him important orders for works of art in his medium, in which he was most proficient. He had always been religious, however, and decided to become a priest. In 640 he was made bishop of Noyon. Throughout his life he had given largely to the poor,

daily feeding numbers of them at his house. He took pity on malefactors and gave them burial, and also ransomed many prisoners. Eloi died in 659. He is the patron saint of jewelers and goldsmiths.

ELONGATION, in astronomy, is the angular distance between the moon, or a planet, and the sun.

EL PASO, a port city in westernmost Texas on the Mexican border, the county seat of El Paso Co. It is situated on the Rio Grande River, opposite the old Mexican city of Juarez, 510 mi. west-northwest of Austin. Five United States railways and two Mexican railways, bus and truck lines, and airplanes serve the city. El Paso is part of the Rio Grande reclamation project, irrigated from the Elephant Butte reservoir. Principal crops include cotton, alfalfa, fruits and vegetables. Cattle raising and mining are leading activities, while ore smelting and copper and petroleum refining are among the major industries. In 1929 the total factory output was worth about \$24,600,000; copper and lead smelting is the chief industry. The wholesale trade proper for 1929 amounted to \$34,020,262; the retail trade amounted to \$54,848,735 the same year. El Paso is the seat of the College of Mines and Metallurgy of the University of Texas. Adjoining the city is Ft. Bliss, a United States cavalry post.

El Paso lies against a picturesque background of mountains, and 1 mi. west of the city is the lowest snow-free pass of the Rocky Mountains. In 1880-81 three railways raced to gain advantage of this easily traversed pass. The city is a center for treatment of respiratory diseases. Cabeza de Vaca, the first white man to see the place, came here in 1536, and in 1659 the first settlement was made on the south bank of the Rio Grande. The town was laid out in 1858; the city incorporated in 1873. Pop. 1920, 77,560; 1930, 102,421.

EL RENO, a city in western Oklahoma, the county seat of Canadian Co., situated on the North Fork of the Canadian River, about 30 mi. northwest of Oklahoma City. Bus lines and the Oklahoma Electric and the Rock Island railroads afford transportation. The vicinity raises cotton, grain and dairy products, for which El Reno is a shipping center. The industrial activities include cotton ginning, brick making, washing machine manufacture and railroad shop work. Ft. Reno, near the city, was built in 1783 to protect the settlers from the Indians. Gen. Nelson A. Miles's name is associated with the scene. The city was founded about 1890. At Concho, 6 miles from El Reno, the Government maintains an Indian agency and an Indian school. Pop. 1920, 7,737; 1930, 9,384.

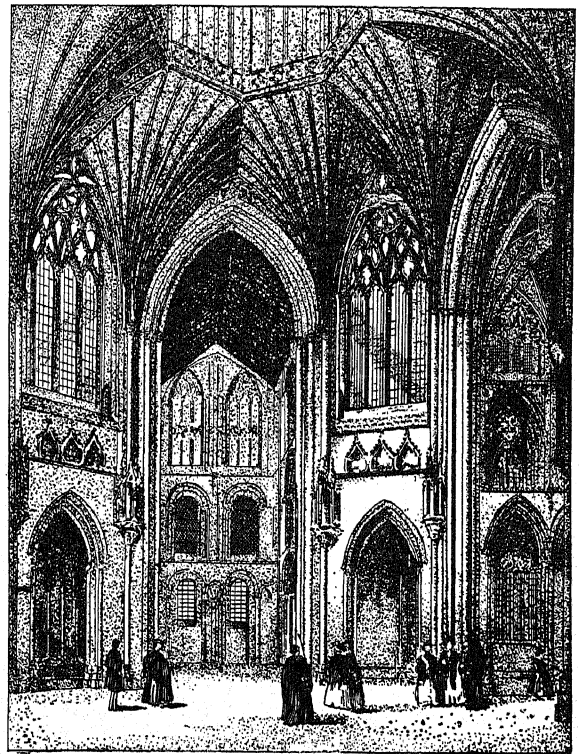
ELWOOD, a city in Madison Co., northeastern central Indiana, 52 mi. northeast of Indianapolis. Bus lines and three railroads serve the city, which is a distributing market for corn, wheat, oats and tomatoes. Elwood's factories produce tin, plate glass and kitchen cabinets. In 1929 the manufactures reached an approximate total of \$12,000,000; the retail trade amounted to \$6,078,152. The city was founded under the name of Quincy in 1852. Re-

named Elwood in 1869, it was chartered in 1891. Pop. 1920, 10,790; 1930, 10,685.

ELY, RICHARD THEODORE (1854-), American economist, was born at Ripley, N.Y., Apr. 13, 1854. He was director of the department of political economy at Johns Hopkins University in 1881-92, professor of political economy at the University of Wisconsin during 1892-1925, and in 1925 was appointed research professor of economics at Northwestern University, and director of the Institute for Research in Land Economics and Public Utilities. In 1904 he founded the American Bureau of Industrial Research, of which he became director, and he was one of the founders of the American Economic Association. In 1907-08 he was first president of the American Association for Labor Legislation. He was one of the first economists to support the theory of government regulation in business affairs. His writings include *Studies in the Evolution of Industrial Society* and *Elements of Land Economics*.

ELY, an episcopal city and market town, celebrated for its cathedral, in the Isle of Ely Co., England, on the left bank of the river Ouse. It has been the seat of a bishopric since 1109.

The Cathedral of Ely was begun in 1083 by the Norman Abbot Simeon. Its site was that of a mon-



ELY CATHEDRAL: THE OCTAGON

astery founded in 673 by St. Etheldreda or St. Awdrey and refounded, after its destruction by the Danes (870), by Bishop Aethelwold in 970. The remains of the ancient monastery include the cloisters, dining

hall, Prior John's Chapel and the Ely Porta or Great Gatehouse, now used by the King's School. The cathedral, measuring 537 ft. in length and 190 ft. across the transepts, is built in four different architectural styles, the Norman, Early English, Decorated and Perpendicular. The Norman portions include the nave (208 ft. long, 77 ft. wide and 73 ft. high), the western transept and the castellated western tower (215 ft. high), all of which were completed by about 1180. In the Early English style are the galilee or western porch, a superb addition made by Bishop Eustace (d. 1215), and the presbytery, built by Bishop Hugh of Northwold (d. 1254). The Decorated Gothic style appears at its best in the Octagon, a tower (170 ft. high) erected at the crossing of nave and transept chiefly by Alan of Walsingham (d. 1328), after the original Central Tower, built by Abbot Simeon, had fallen (1322). Also in the Decorated style are the three western bays of the choir and the lady chapel, both built mainly by Bishop Hotham (d. 1337), and the octagonal top of the western tower. In the Perpendicular style are the windows of the aisles. Extensive restorations were effected throughout the cathedral, after 1845, by Sir G. G. Scott. Of greatest interest inside the cathedral are the painted roof of the nave, by Styleman le Strange and Gambiar Parry (19th century); the chapels of bishops Alcock (d. 1500) and West (d. 1534); the tombs of bishops William de Luda, Northwold and Redman; the 14th-century choir seats; and the 19th-century choir screen and reredos by Sir G. G. Scott. The noted lady chapel is now used as the parish house.

The town of Ely lies in marshlands, and was once surrounded by water. Its records go back to days when monks and nuns sought safety as well as seclusion in these remote fens, and a convent was established here in 673. Historically the "Island of Ely" is famous as the site of the Saxons' last stand, in 1066-71, after the Norman conquest. In the Middle Ages the Bishop was one of the two English prelates who united temporal with spiritual overlordship. Pop. 1921, 7,690; 1931, 8,382.

ELY, a city in St. Louis Co., northeastern Minnesota, situated on Shagawa Lake, 117 mi. north of Duluth. The Duluth Missabe and Northern Railroad affords transportation. The city is in an iron mining locality, and ships iron ore and crushed stone. Ely is the headquarters of the Superior National Forest Service and a center for thousands of tourists every year on their way to the lakes and woods in this region. Pop. 1920, 4,902; 1930, 6,156.

ELY, a town in eastern Nevada, the county seat of Whitepine Co. It is situated 251 mi. southwest of Salt Lake City; served by the Nevada Northern Railroad. Ely is surrounded by copper, gold, lead and silver mines. Grain is grown in this region. Pop. 1920, 2,090; 1930, 3,045.

ELYOT, SIR THOMAS (c. 1490-1546), English writer and diplomat, was born probably at Wiltshire about 1490. He himself states that he was largely self-educated. In 1530 Wolsey appointed him clerk

to the Privy Council. The following year he wrote his *Boke named the Governour*, a popular work on moral philosophy designed for the education of princes. It was modelled on Patrizzi's *De regno et regis institutione*. Elyot was twice ambassador for Henry VIII to Charles V, and in 1542 represented Cambridge in Parliament. Among his works are a Latin dictionary and translations from Greek and Italian writers. This dictionary was edited and enlarged by Thomas Cooper, Bishop of Winchester, and became the basis of his *Thesaurus*. Elyot died at Carleton, in Cambridgeshire, Mar. 20, 1546.

ELYRIA, a city of northern Ohio and county seat of Lorain Co., on the Black River, 9 mi. from Lake Erie and 25 mi. southwest of Cleveland. The Baltimore and Ohio, and the New York Central railroads, and La Porte Field, a commercial airport 3 mi. northeast, serve the city. Berea sandstone is quarried near by. Elyria's leading manufactures include motors, fishing-tackle, golf balls and bags, children's vehicles, steel tube and screw-machine products, furnaces, heaters, bakelite products, hosiery and lace. In 1929 the value of the factory output was about \$37,000,000; the retail trade amounted to \$16,917,415. Cascade Natural Park has a historic and geological interest, as well as great scenic beauty. The International Society for Crippled Children was founded and has its headquarters in Elyria. OBERLIN COLLEGE is at Oberlin, 9 mi. to the southwest. Elyria, founded in 1817, became a city in 1892. Pop. 1920, 20,474; 1930, 25,633.

ELYSIAN FIELDS. See **ELYSIUM**.

ELYSIUM, the **ELYSIAN FIELDS** or **ELYSIAN PLAIN**, in classical mythology, the abode of perfect bliss, inhabited by the heroic or pious dead. It was situated at the ends of the earth on the River Oceanus and ruled by Rhadamanthys or according to some authors, by CRONUS. Those who dwelt there were immortal. According to one tradition, the gods decided who were to be allowed to attain this happiness. The Islands of the Blessed were sometimes identified with the Elysian Fields. In later writings Elysium is made a part of HADES.

EM. See **POINT SYSTEM**.

EMANATION, a sort of vapor or light-giving substance given off by the human body and said to be visible to properly sensitive subjects. Something of this order attaches to objects by which mediums can read the traits of the owner. See **PSYCHOMETRY**.

EMANCIPATION PROCLAMATION, a declaration issued by President Lincoln Sept. 22, 1862, announcing that on Jan. 1, 1863 all persons held as slaves in any state in which the people were in rebellion should thenceforward and forever be free, and that the President of the United States would maintain the freedom of such persons. The proclamation was issued in Lincoln's capacity as commander-in-chief of the army and navy rather than as chief civil executive. He declared it "an act of justice, warranted by the Constitution, upon military necessity." Lincoln had decided upon the proclamation in July,

1862, but withheld it until the Union troops should have won an important victory. The **BATTLE OF ANTIETAM** provided the occasion.

EMANUEL I (1469-1521), 14th King of Portugal, called the Great and the Happy, was born May 3, 1469. His reign which began in 1495 marks the golden age of Portugal. Vasco da Gama opened an all sea route to India, Corte-Real reached Labrador, Albuquerque was made Portuguese viceroy in India and commercial relations were opened up with Persia and China—all during this reign. Emanuel was a patron of art and science and issued the code of laws bearing his name. His reign was a period of Jewish persecution. He founded many monasteries and actively promoted missionary enterprises in countries he acquired. Emanuel died at Lisbon, Dec. 13, 1521.

EMAUS, a borough in Lehigh Co., in southeastern Pennsylvania, situated 45 mi. northwest of Philadelphia and served by the Reading Railroad. The leading manufactures are silk, cast iron piping and building materials. Potatoes are the chief crop of the vicinity. Emaus was settled by the Moravians in 1723, and later was named for a famous bishop of the Moravian church. Pop. 1920, 4,370; 1930, 6,419.

EMBALMING, a method of preserving the dead human body. Primitive peoples used aromatics and dried the body by sun or stove. In a treatment lasting 70 days, the Egyptians eviscerated and placed aromatics in the body, then immersed it in a solution of carbonate, sulphate and chloride of sodium. The body, being next wrapped in bandages soaked with gums and resins, was placed in a mummy case if the person was of sufficient importance. Such mummies have resisted decomposition for more than 4,500 years. With the fall of Egyptian civilization, embalming, a priestly function, disappeared.

The preservation of cadavers for dissection dates from about 1700, after preservative chemicals and the functions of the arteries, veins and capillaries had been discovered. This preservation of dead bodies greatly advanced anatomical knowledge.

Modern funeral embalming began about 1862, when it was necessary to return the bodies of deceased Union soldiers to their homes. In 1882 regular professional training was offered. Approved methods of to-day involve the saturation of body tissues with preservative solutions by way of the blood vascular system. Embalming is now a professional practice employing the principles and methods of chemistry, physics, bacteriology and histology. C. O. D.

EMBARGO, an order of government forbidding the departure of ships or the exportation of commodities. An embargo effects a partial or total cessation of foreign trade. When operative only upon domestic shipping and domestic goods such measures are said to be civil or pacific. When extended so as to include the detention of foreign shipping an embargo is said to be hostile. The Congress has empowered the President of the United States to lay an embargo upon the exportation of arms and ammuni-

tion to any American country in which "conditions of violence exist."

E. A. K.

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EMBER DAYS, and **EMBER WEEKS**, certain periods of the ecclesiastical year in the Western churches, devoted to special prayer, fasts and the ordination of the clergy. The days are 12 annually, and fall on the Wednesdays, Fridays and Saturdays after the Festival of the Holy Cross (Sept. 14), the Festival of St. Lucia (Dec. 13), the first Sunday of Lent and after the feast of Pentecost or Whitsunday. The Ember Weeks, sometimes called Embertide, are those in which the days occur. The ordination of the clergy is conducted on the Sundays following the Ember Days, this rule dating from the time of Pope Gelasius (492-96). Ember Days were appointed by Pope Urban II at the Council of Placentia, 1095, but they were observed in Spain and Gaul in the 8th century and in England as early as 597. Originally they may have been substitutes for pagan nature-cult observances sanctifying the four seasons.

EMBEZZLEMENT, the unlawful appropriation of property by one who originally had rightful possession. It is a purely statutory offence, not being a crime at **COMMON LAW**. The elements of embezzlement as generally defined by statute are (1) the thing taken must not have been absolutely valueless; (2) ownership must not have been in the accused; (3) the property must have come into his possession lawfully; (4) he must have come into possession by virtue of some fiduciary relationship with the owner; (5) he must have appropriated it with fraudulent intent to deprive the owner of his property. Appropriation under bona fide claim of right is not embezzlement. The persons designated by statute as those in the relationship requisite for the commission of this crime are servants, clerks, employees, agents, bailees, attorneys, guardians, executors, administrators, trustees, or persons having possession under an agreement with the owner. Punishment is fixed by **STATUTE**, and may be by fine or imprisonment or both, the extent of the punishment being in some jurisdictions fixed by the value of the thing embezzled.

N. G.

EMBLEM, an object, or representation of it, which symbolizes another object, event, quality, person, or body of persons; originally an inlaid ornament affixed to a vase or precious vessel. The so-called emblem popular in England in the 17th century consisted of a sketch or picture accompanied by verses or a motto designed to point a moral lesson. Emblems have been devised for many Christian saints, and to this category belong the well-known keys of St. Peter, the lamb of St. John the Baptist, and the dragon of St. George. An early emblem for Christ was a fish—the letters of the Greek word for fish, *Ichthus*, standing for "Jesus Christ Son of God the Savior." An emblem for God is a hand stretched from the clouds; for the Virgin, a lily; for Adam, a spade. A scepter denotes sovereignty; a balance, justice; and a circle,

eternity. Besides their use in HERALDRY, emblems are used by nations, states, universities and schools, clubs, corporations and the like.

EMBLEMENTS, crops planted by a tenant and entitled to be moved away by him, e.g., he can gather hay from grass he has sown, but he cannot take away grass which was growing or spontaneously grew on the land he leased.

EMBOSSING, the process of printing a design in relief on a surface. Brass dies are best suited to embossing, unless the run is short, the stock light, and the design in low relief. For long, heavy duty runs a metal counter die is advisable, to avoid frequent replacement. Ordinary embossing calls for a female die, with the raised parts of the design etched or carved away. With this secured in the press, the stamper proceeds to build up the counter on the bed of the press, using a strong, dense cardboard. The counter must be the exact reverse of the die, so that when the stock is impressed between the two, it will be forced upward into the details of the upper die. Comparatively light paper stock can be embossed without heat, but on heavy stock the work is facilitated and the detail sharpened by heating the die. In preparing heavy book covers for superfinish decoration, heat is essential. Odd-shaped cardboard cut-outs are often embossed and cut or died out with a combined die in one operation. E. W. P.

EMBROIDERY, that branch of needlework which consists of working a design or decoration with thread on a textile material of some kind. Embroidery came into use with the first needles, whether fish-

pottery and metal, on which elaborate needlework on wearing apparel, tents, hangings and horse trappings is pictured. Almost no examples of the embroidery itself have survived. Fragments of embroidered fabrics have been found in Egyptian tombs, and some of the Christian Coptic pieces, executed between the 6th and 9th centuries, are in existence. Byzantium was celebrated for its wonderful embroideries after the commencement of the Christian era. The Persians and other peoples of the East produced embroideries on which the original material was entirely covered by stitching. Both China and India claim to have practiced embroidery many centuries before Christ.

From the 5th century on, France produced much embroidery for the use and embellishment of the



COURTESY M. M. OF ART
PERSIAN COPE OF EMBROIDERED VELVET
18th century

bones, thorns or similar instruments, which were used by primitive man to sew skins together for covering. The pattern which the coarse stitching took was the first embroidery. Records of Grecian, Assyrian, Babylonian and Persian embroidery have been left in stone,

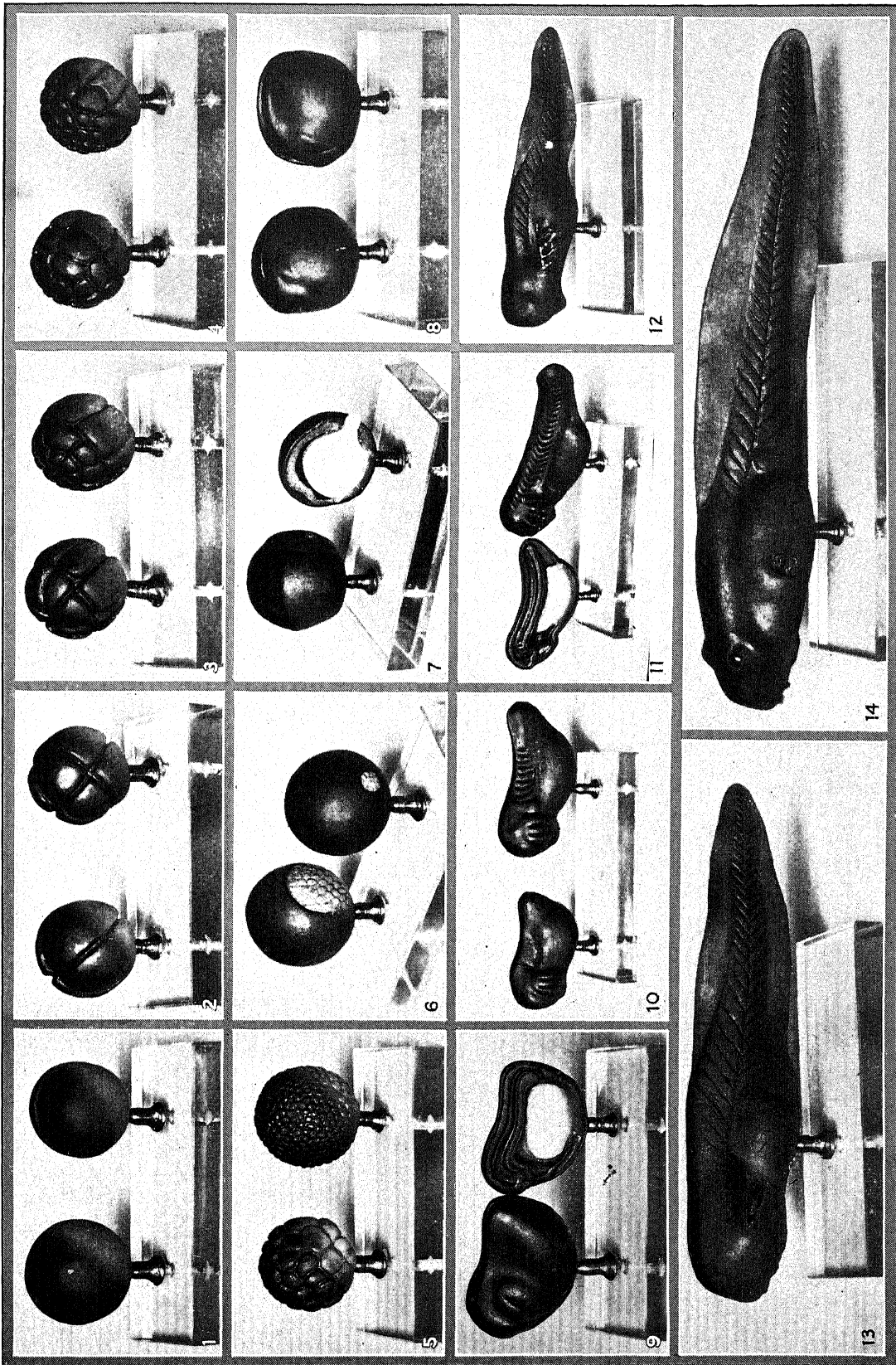


COURTESY M. M. OF ART

EMBROIDERED SATIN CHASUBLE
French, 16th century

church. The art began to develop in England soon after the conversion of the Anglo-Saxons to Christianity, and in the 13th and 14th centuries England became world-famous for the beauty and magnificence of her ecclesiastical embroideries. Many of these pieces still exist in museums, churches and private collections. The most celebrated is the Syon cope in the Victoria and Albert Museum in London. After the Reformation, English embroiderers turned to the decoration of garments for the wealthy. During the reign of Elizabeth, the peak of extravagance in nee-

EMBRYOLOGY



COURTESY AMERICAN MUSEUM OF NATURAL HISTORY

STAGES OF DEVELOPMENT OF FROG EGG AND EMBRYO

1. *Left*, appearance of poles, pigmented light and dark; *right*, beginning of segmentation—two-celled stage. 2-5. Progressive segmentation, four-celled, eight-celled, sixteen-celled, etc., stages. 6-7. Yolk development. 8-14. Embryo development, showing changes in formation of head, brain divisions, spine, gill slits, visceral cavities, tail, suckers, fringed

dlework applied to dress was reached. The use of embroidery spread to household articles, book coverings, purses, bags, gloves and hangings for windows and beds. Superb work was done in Spain, France, Italy and England. The Chinese and Japanese achieved remarkable effects in shading and in thin flat treatment of floral designs, and in Turkey and Persia motives similar to those of their woven fabrics were used.

In the 17th century, following the appearance of petit-point and the English stump-work, came a great fancy for patterns in the Oriental taste. The art of quilting garments and bedcovers became popular in England in the 18th century, and was carried into the American colonies where it persisted until the end of the 19th century. Chenille embroidery was introduced from France. Beads and spangles came to be intermingled with embroidery, and combinations of embroidery and painting grew popular. In the 18th century, France, England and America produced beautiful embroidered muslins, tulles and nets, and continued to do so until the introduction of machine work. Lately there has been a revival of artistic needlework, with schools established in the United States and Great Britain to teach the art.

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EMBRYOLOGY, a subdivision of biology or life science dealing with the developmental period of the life cycle. The early formative period is the embryonic period, the individual during this phase is an embryo. Since adult organisms differ enormously in size and complexity of organization it is obvious that the embryonic period correspondingly varies. In the lowest and simplest forms of life, as protozoa, protophytes or bacteria, this phase is nearly or completely lacking. In the higher animals development continues beyond a period strictly embryonic. While a period of embryonic development may be initiated by other methods of reproduction, sexual reproduction so greatly varies that it alone is considered here. The initiation of each individual begins with the fertilized egg or ZYGOTE.

Fertilization. The entrance of the male reproductive cell, the sperm cell or spermatozoon has two results: 1. It introduces from the male parent a nucleus with a characteristic complement of chromosomes. This unites with the nucleus within the mature egg cell and thus provides the zygote with a double, diploid, number of chromosomes. 2. The spermatozoon stimulates the dormant egg to heightened vital activity and successive mitotic cell divisions. This constitutes the first stage of development, which is *cleavage*.

The sperm cell in different animals may possess quite different forms. Typically it consists of a head, embodying a condensed nucleus, a middle piece and a vibratile flagellum, the tail. The nucleus is, however, essentially the only contribution to the offspring made by the male parent. The egg provides the material for early development. Even the smallest egg is large

when compared with most cells. Furthermore, within the egg there is provided a store of foodstuff, inert material, known as the yolk. The amount of such material bears direct relation to the future developmental requirements of the individual. Where the offspring is able through its own activity early to meet the life conditions, the amount is slight. The deutoplasm in the yolk or egg cell of the hen's egg is enormous, since provision must be made for a period of 21 days until hatching. In the mammal, man, dog, or cat, the egg so soon reaches the uterus or womb where an inexhaustible supply of foodstuff, water and oxygen are available, that little is stored within the egg which is correspondingly small. Thus eggs vary greatly in the amount and in the distribution of yolk.

Cleavage. During the cell division of the zygote and in all subsequent divisions the diploid number of chromosomes is maintained, the paternal and maternal groups remaining distinct throughout the life cycle. Only in the last two divisions leading to the production of the germ cells at sexual maturity is there a union of chromosomes in pairs and a subsequent separation of these pairs, thus reducing the number of chromosomes to the simple (haploid) number characteristic of the reproductive cells. During cleavage in many forms the presence of yolk markedly alters the method of cell division and its influence extends to all subsequent stages.

Gastrulation. The cleavage stage in most animals gives little indication of the future embryo. With the succeeding stage, gastrulation, the orientation becomes definite. Gastrulation, as the name implies, is characterized by the appearance of the primitive digestive cavity, the archenteron with its lining the inner germ layer, the entoderm. This inner layer may arise in different ways, but usually some form of infolding takes place leaving an opening to the exterior, the blastopore. This in different animals becomes the mouth or the anus or is divided into mouth and anus. It may remain open or be temporarily closed.

Germ-layers. The ectoderm and entoderm formed in gastrulation are the primary germ layers and in some simpler animals, they alone are present. Usually, however, a middle germ layer, the mesoderm develops between the two. No uniform mode of origin for the mesoderm exists. Within it develops a characteristic cavity, the body cavity or coelom. In the arrangement of the germ layers the plan of the future body is foreshadowed. This is typical for each group of animals. From the time of gastrulation when the germ-layers appear, development becomes more specific. Growth is very rapid and an accompanying differentiation gradually produces the characteristic bodily form and structure.

In certain animals, e.g., mollusks and certain worms the destination of the cells is clear from the earliest cleavage, and experiments indicate that their fate is irreversible. This early determination depends upon the organization of the egg. Most eggs evince a cer-

tain foreshadowing of the future body and in certain instances, e.g., ascidians, this is very marked; definite regions correspond to definite portions of the adult. Often it is assumed that there are definite organ-forming substances responsible for the determinate character of development. However in certain other animals the determinations occur later. Thus, in the sea urchin egg if the first four cells, the blastomeres are separated each forms a perfect larva (*pluteus*) but one-fourth normal size. Had they remained in association each would have formed one-fourth the body of a full-sized larva. In the salamander a fine hair loop drawn tight between the first two cleavage cells may separate them. Each then develops as though an individual egg. Double monsters in man and other animals represent an imperfect division of a single egg, and identical twins are the result of complete division. After gastrulation the potencies and developmental possibilities become restricted. It would appear that in general as development advances and differentiation becomes marked, the potencies become correspondingly more limited and precise.

Fetal Membranes. The embryonic period by its very nature is one of individual helplessness, and yet the fundamental life requirements, food, water, oxygen, heat, protection, care of waste products and the like must always be met. The primary method of providing the food is by deposit within the egg. In reptiles and birds foodstuff or albumen and water are provided within the shell. Oxygen is absorbed through the shell, and incubation furnishes the heat. The embryo develops on the surface of the yolk and to meet the developmental needs four temporary structures, the fetal membranes, are formed: Amnion protecting the developing embryo; the yolk sac for the utilization of the yolk; allantois providing for respiration and serving as a urinary reservoir; the chorion (*serosa*), an outer membrane. These attain their development in orderly sequence and are discarded at hatching. Man and other mammals have the same membranes to meet the same needs. The chorion, however, which provides the fetal placenta, gains an added importance because of its attachment to the uterus. Due to these membranes higher vertebrates are termed the Amniota.

Embryology in its general aspects is closely linked to HEREDITY and explanatory theories must take account of both. In its special applications it contributes an essential chapter in the history of each life form. Many congenital abnormalities are developmental and embryology alone renders them comprehensible.

B. F. K.

EMDEN, a city in the northwestern corner of Germany, $2\frac{1}{2}$ mi. from the north shore of Gulf Dollart. It has a large exterior harbor 3 mi. from the inflow of the Ems, and is at the mouth of the Dortmund-Ems Canal, from which the Ems-Jade Canal branches to Wilhelmshaven. The city has old buildings, religious and secular, and houses that suggest Holland. It manufactures machines, cigars, to-

bacco, rope, cement and leather, has shipyards, a large shipping trade and much deep-sea fishing. It is also the central cattle market for East Frisia. Pop. 1925, 27,807.

EMERALD, a clear, green mineral, one of the most precious stones known, frequently bringing higher prices than the diamond. In appearance it has a glassy or resinous surface and is transparent to translucent; the color may vary from dark to light. The stones are sometimes muddy or flawed, and flawless ones of good color are rare. Since the hardness of the emerald is extreme, only slightly less than that of the ruby and sapphire corundum, it is durable and retains its polish. It is one of the colored varieties of BERYL, thus belonging to the same group as the aquamarine, heliodor, morganite and golden beryl. The green coloration of the emerald variety is due to traces of chromium. Chemically the emerald is a silicate of beryllium and aluminium, crystallizing in the HEXAGONAL SYSTEM.

The beryl gems, including emerald, have weak refractivity and dispersion, and accordingly show little brilliancy and no fire. The appeal of the emerald is therefore based on its color, the deeper greens being favored. These specimens often are PLEOCHROIC, the shade of green being slightly different in two directions through the crystal. Emeralds are generally cut step, sometimes brilliant, and occasionally are carved.

Upper Egypt was the source of emeralds in ancient times, when they were called *smaragdus*. Colombia, in South America, now provides the best stones, where they are found disseminated through a metamorphosed limestone. They are also found in schists in the Ural Mountains and sometimes in gneisses in North Carolina. The Oriental emerald is a green variety of SAPPHIRE; the evening emerald is another name for the PERIDOT. See also GEM STONES; PRECIOUS STONES.

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EMERGENCE, the theory which holds that certain phenomena cannot be adequately explained by what has gone before, i.e., that at certain points in nature new elements emerge which are not entirely accounted for by what has preceded them. This theory is best expounded by Lloyd Morgan in his *Emergent Evolution*. It is impossible to predict the appearance of an emergent. Yet when it appears it may be studied empirically. Running through the various levels of sensitivity it would be impossible to deduce perception from the sentience of the amoeba, or to derive reason from perception. These are emergents which appear in the course of evolution.

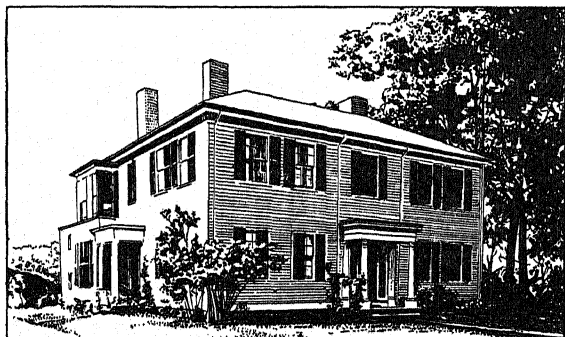
EMERGENCY LEGISLATION. The filing of a referendum petition relative to the enactments of the state legislature has in a number of states the effect of a temporary suspension of the law so challenged, until a popular vote has been taken. In certain of these states, however, a provision has been written into

the state constitution which permits the legislature to declare any measure relative to the public peace, health or safety exempt from such suspension on the grounds that an emergency exists.

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EMERSON, RALPH WALDO (1803-82), American essayist and poet, was born in Boston, Mass., May 25, 1803, the descendant of a long line of Massachusetts ministers. His father, Rev. William Emerson, pastor of the First Church in Boston, died in 1811, leaving his widow in straitened circumstances with the burden of supporting six children. Poverty thus cast a shadow over Emerson's boyhood, which, however, though he was not active in the usual boyish ways, seems not to have been unhappy. After attending a dame school, a grammar school and the Boston Latin School, Emerson entered Harvard in 1817, and in 1821 graduated as Class Poet, though without having distinguished himself in scholarship or profited much, in his own opinion, from the educational routine. After three or four not very satisfactory years at a school for girls in Boston, originally as assistant to his brother William, he entered the Divinity School at Cambridge, in 1825, and in 1826 was granted the approbation to preach by the Middlesex Association of Ministers. Ill health dogged Emerson's footsteps throughout most of his twenties, and more than once he was forced to give up his studies and his preaching for weeks of idleness or of travel in the South. In 1829, however, he became associate minister and later minister of the Second Church (Unitarian) in Boston, and during the same year married Ellen Louisa Tucker, of Concord, N.H., who died during the third year of their marriage.

In 1832, the year of his wife's death, Emerson took one of the most decisive steps of his career by resigning from his ministry in Boston owing to a disagreement with his congregation respecting the Lord's Supper. From now on, though he was to continue to preach occasionally until 1847, his position was to be more and more that of a theological radical. Traveling in Europe in 1832-33 he visited and talked



RALPH WALDO EMERSON'S HOME AT CONCORD, MASS.

with the men, such as SAMUEL TAYLOR COLERIDGE and THOMAS CARLYLE, who had already begun to influence him and through whom he tapped the sources of German idealistic philosophy. Returning

to America, and finally settling in Concord, Emerson began, in his public lectures and then in his writings, to attack the spiritual sterility both of Calvinism and Unitarianism; and to advocate in their stead a new gospel of nondoctrinal spiritualism, of idealistic self-reliance, and of optimistic affirmation. In his first book, *Nature*, 1836, in two daring addresses—the Phi Beta Kappa oration at Harvard in 1837 on “The American Scholar,” and the address before the graduating class at the Divinity School in Cambridge in 1838—and in public lectures used as the basis for his first series of *Essays*, 1841, he made himself the object of much unpopularity in orthodox and conventional circles. But it was in these utterances too that he made himself the acknowledged leader, and ultimately the revered leader, of the whole new movement in American thought which centered, in the '30s and '40s, in the group of men and women later known as the Transcendental Club. Largely to his inspiration American literature is in debt for the writings of such Transcendentalists as HENRY DAVID THOREAU, MARGARET FULLER and WALT WHITMAN.

Despite the intensity of his spiritual life, the rest of Emerson's career was relatively serene and prosperous. In 1835 he had married Lydia Jackson of Plymouth; a small regular income enabled him to become a householder and land-owner in Concord; and here, in the midst of friends such as BRONSON ALCOTT, Thoreau and NATHANIEL HAWTHORNE, the remainder of his days was spent. The modesty of his fortune, it is true, forced him to continue his labors as a lyceum speaker until after the Civil War; and winter after winter he went on long lecturing tours even into the wilderness of the Mississippi Valley. In 1847-48 another voyage to Europe resulted in a volume on *English Traits*, published 1856; and later lectures went into the substance of *Representative Men*, 1850, *The Conduct of Life*, 1860, *Society and Solitude*, 1870, and *Letters and Social Aims*, 1876. In 1846 he had published a volume of *Poems*, and in 1867 another volume, *May Day and Other Pieces*, appeared. During the '50s, Emerson threw himself, for the only time in his life, into the heat of practical politics. A growing ardor of feeling on the question of slavery led him, against temperamental hesitations, to ally himself with the Abolitionists, and he now courted a new sort of unpopularity, even some physical danger, in public addresses on such issues as the Fugitive Slave Law, the Kansas troubles and John Brown. The Civil War found him passionately devoted to the Union cause, and he early recognized and celebrated the genius of Lincoln. Though he survived the close of the war by 16 years, he was never again to be stirred by a public cause; and his later life, save for the shock given to him by the burning of his home in 1872, was not only uneventful but even a little featurelessly placid. Failing powers of memory and mental grasp did nothing to mar the serenity of his temper or to undermine what C. E. Norton called the “fatalistic optimism” of his outlook; and his last days had no element of trag-

edy in them. He died of pneumonia Apr. 27, 1882, and was buried at Concord, near Thoreau and Hawthorne, in Sleepy Hollow Cemetery.

Probably no American writer embodies in his work more sides of American spiritual history than Emerson. His roots were deep in the Puritan past; his leadership of individualistic expansiveness in his own day was marked; and since his death he has influenced virtually all those American writers, as, for example, William James, who have stood for moral seriousness, self-help, self-reliance, the gospel of "cheerfulness and courage," progress as understood by systematic liberalism, and religious heterodoxy. As a writer, despite certain limitations of incoherence and formlessness, Emerson is not to be surpassed for the incisiveness, the frequently homely pungency, the metaphysical wit, and, again and again, the radiant eloquence of his prose. *See also* AMERICAN LITERATURE.

N. AR.

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EMERY, an impure variety of CORUNDUM, black or grayish in color, consisting of an intimate mixture of corundum, aluminium oxide with MAGNETITE or HEMATITE and sometimes hercynite, an iron SPINEL. It resembles a black, fine-grained iron ore, which it was once considered to be. There are gradations from evenly fine-grained varieties to those in which the corundum is in distinct crystals. Emery is found in boulders on some of the Grecian islands, in granular limestone in Asia Minor, and also in Bohemia, England, in the State of New York and in veins in Massachusetts. Emery is used as an abrasive and polishing agent. *See also* ALUMINA.

EMETICS, agents capable of producing emesis, or vomiting. The normal stomach will reject anything that causes irritation, often before any injury to the wall of the stomach has occurred, the vomiting thus being a useful protective reflex. To secure vomiting for remedial purpose, e.g., when the stomach contains material that if passed on would be detrimental to the system, those agents are selected as emetics that have no otherwise deleterious effects. Among these, zinc sulphate in doses of 2 to 3 grains in 1 to 2% solution every 5 to 10 minutes until vomiting has occurred, but not to exceed a total dose of 15 grains, is one of the best. For children, syrup of ipecac is usually sufficiently powerful to produce emesis when given in teaspoonful doses every 5 to 10 minutes. This is an old and well known means of relieving spasmodic croup. The vomiting helps in the removal of the obstructing plug of laryngeal mucus, and the succeeding muscular relaxation favors cessation of the spasm. Curiously enough, there are certain agents—most prominent among which is apomorphine—that produce vomiting, when a most minute dose is injected under the skin, by acting directly on the "vomiting center" in the nervous system. Such agents might

be preferred as emetic, when the patient cannot or will not swallow, or when all gastric irritation must be avoided. *See also* VOMITING.

B. F.

EMEUS, a large bird of the ratite family *Dromiceidae*. There are two species both native to Australia. They are ostrich-like in form, standing about 5 ft. high, but the body is more bulky and the legs and neck are shorter in proportion than in the ostrich. The wings are rudimentary, and concealed by the long filamentous gray plumage; this is very scanty on the neck and head. Emeus inhabit plains and open country, depend on their feet for travel and defense, and feed on herbage, fruits and roots, frequently damaging unfenced crops. They are easily domesticated and their flesh is edible; some ornamental use is made of the feathers and their skins were used by the aborigines for robes.

EMIGRATION. *See* IMMIGRATION.

EMIGRÉS, voluntary exiles from France during the French Revolution. Disgusted with the concessions to the Third Estate, and the weakness of the King after the fall of the Bastille on July 14, 1789, many of the most reactionary of the upper nobility, led by the King's brother, the Count of Artois, left France and settled in the cities like Coblenz, Mainz and Worms on the eastern border. There they set up courts, gathered troops and carried on intrigue and plots to secure intervention against the Revolution. In 1792 they were partially successful, though the intervention of the Emperor and the King of Prussia served rather to unite the French than to help the emigrés. At the same time it increased the hostility of the revolutionists toward the emigrés and those of their class still in France, against whom renewed persecution broke out with each step in the progress of the Revolution. Thousands of the lesser nobility, more than half the clergy and many bourgeois were driven into exile. In the meantime, the Revolution confiscated their property and declared them outlawed unless they returned by a certain date, which they did not do. The security offered was inadequate. With the change of government from the Directory to the Consulate, Napoleon issued a decree permitting the emigrés to return, but many, like the princes of the Bourbon family, refused. In 1814, on the abdication of Napoleon, Louis, the oldest of the brothers, returned to Paris to become Louis XVIII. With him came thousands of others who had been in exile, many of them for 25 years. Upon the return of Napoleon from Elba, however, many again fled, only to return in 1815 in "the baggage of the Allies." Their hopes to regain their former estates and privileges were disappointed; even the attempts during the reign of Charles X to reimburse them by money payments were only partially successful.

EMINENT DOMAIN, the right of governments to take PRIVATE PROPERTY for public use. Examples are the condemnation of property in opening streets and the obtaining of land for public buildings and other things needed by government. The individuals, however, are fully reimbursed.

EMISSION SPECTRUM. LIGHT passing through a PRISM or a DIFFRACTION GRATING becomes spread out into a series of component COLORS, called a SPECTRUM. If the light, after leaving its source, has not been acted upon by any absorbing material, the series of component colors is termed an *emission spectrum*. Otherwise the spectra are termed ABSORPTION SPECTRA.

There are three types of emission spectra, viz., continuous, band and line spectra (*see* SOLAR SPECTRUM; BAND SPECTRUM; LINE SPECTRUM). In a continuous spectrum there is an unbroken sequence of color, from red through yellow, green and blue to violet, with all the intermediate gradations. With appropriate instruments, the existence of invisible light on both sides of this series has been established, on one side the infra-red, on the other the ultra-violet. In a band spectrum, many colors in what would otherwise be a continuous spectrum are absent, leaving only a peculiar sequence of colored flutings. These flutings, when seen with a low-power SPECTROSCOPE, appear as bands of color, each band being sharp at one edge, and grading off gradually to darkness at the other. In a line spectrum all portions of what would otherwise be a continuous spectrum are dark except for some very narrow regions, so that the effect is that of colored lines on a dark background.

A continuous spectrum is produced when the luminous source is a solid or liquid, e.g., an incandescent electric lamp FILAMENT or a mass of molten metal. A band spectrum is produced by a gas in a molecular state of AGGREGATION, while a line spectrum is produced by a gas which is in an atomic state.

L. W. T.

EMISSIVITY, in physics, the ratio I_s/I_b , where I_s and I_b are the intensities of the RADIATION of a definite wave-length emitted at a particular temperature by the substance in question and by a BLACK BODY RADIATOR, respectively. The emissivity depends upon the nature of the emitting surface and upon the wave-length and temperature at which it is measured. Emissivity is used sometimes to denote the total amount of energy radiated per sq. cm. per sec. by a body when its temperature is 1° C. higher than that of its surroundings.

EMMANUEL (Hebrew for God-with-us), a Hebrew proper name first assigned by the prophet Isaiah as a token of divine protection (Isaiah 7: 14-16). In the New Testament the name is conferred on Jesus as signifying the Messiah (Matthew 1: 23). Christian liturgical phraseology often applies the term as an appellation for the Savior.

EMMER, a hardy variety of WHEAT (*Triticum aestivum* var. *dicoccum*) with a somewhat flattened, dense, heavy, bearded fruiting-head or ear in which the ripened grain remains attached to the chaff. Emmer is extensively cultivated in Russia and Germany for stock food and is occasionally made into porridge; it is also of some importance in the north-western United States for feeding cattle and for the manufacture of breakfast food.

EMMET, ROBERT (1778-1803), Irish patriot, born at Dublin in 1778. He entered Trinity College, Dublin, in 1793, where he won high honors in scholarship and especially distinguished himself as an orator. In 1798 he clashed with the authorities and, as a protest against examinations required by them as to students' political leanings, he left the University and went abroad to escape arrest. After a year of travel on the Continent, he became affiliated with the Irish rebels of 1798, and in Oct., 1802, left Paris to conduct the revolution seething in Ireland, expecting the cooperation of Bonaparte. The conspirators' plans, however, miscarried, and on July 23, 1803, his attack upon the arsenal and castle of Dublin ended in failure, and in the murder of Lord Kilwarden. Emmet was forced to hide in the mountains. Wishing to meet Miss Sarah Curran, to whom he was engaged, he became unwary and was apprehended, brought to trial, and hanged at Dublin, Sept. 20, 1803, delivering a great patriotic oration on the scaffold. His friend, Thomas Moore, celebrated this unselfish youth in his *Irish Melodies*.

EMORY UNIVERSITY, at Atlanta, Ga., controlled by the Methodist Episcopal Church, South, was founded in 1836 as Emory College at Oxford, Ga. In 1914 it became part of the newly created Emory University. The institution was moved to Atlanta in 1919. Women are admitted only to certain departments. The productive funds in 1931 were \$4,636,905. The library of 115,000 volumes contains the Thurzfield Smith Collection of Wesleyana, the Park Collection on the Civil War and the original manuscripts of Joel Chandler Harris. In 1931-32 there were 2,051 students, and a faculty of 257 headed by Pres. Harvey W. Cox.

EMOTION, a complex feeling in the form of reflex action. It was the James-Lange theory that gave the emotions a definite physiological basis, tying them up with instinctive action. Emotion is not the result of bodily activity but is the activity itself; it is not the cause of action but is a part of it. We do not run because we are afraid; we are afraid because we run. The visceral and body sensations accompanying the act of running are the emotions. Emotion is thus immediate and direct. The bodily changes are not the effect of emotion; they are the emotion.

The James-Lange theory has been widely accepted and still holds its own as one of the most satisfactory explanations of the emotions, although there has recently been developed some experimental evidence against it. McDougall makes emotion an accompaniment of instinct. The primary instincts have their accompanying emotions, emotion being but one phase of an instinctive act. Thus the instinct to fight has its corresponding emotion of anger and the instinct to flight the emotion of fear. With the change in the conception of instinct has gone the acceptance of this view. Emotion has also been regarded as due to a blocking of desire. When an impulse has been unduly inhibited the blocked energy gives rise to an emotion. This is the position taken by Dewey and accounts for

the rôle of emotion in the process of adjustment. The older view of Darwin regarded gesture as an expression of the emotions.

Marston would make emotion an integration of motor impulses just as perception might be regarded as an integration of sensory impulses. From the standpoint of psychoanalysis, emotion centers pretty largely about the libido and the activities of the ego. Watson recognizes but three emotions in the infant, *viz.*, fear, anger and love. Anger may be elicited by thwarting the child's free movement of limbs, fear by either a loud noise or a falling sensation and love by stroking the erogenous zone.

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EMPEDOCLES (c. 490-430 B.C.), a Sicilian philosopher. He was so esteemed and admired that he regarded himself almost as a king, assuming the insignia of royalty and surrounding himself with a court. He was a poet, statesman, orator, and was also celebrated for his knowledge of natural history and medicine. His philosophy was largely Pythagorean. The miraculous cures effected by Empedocles brought him widespread celebrity. He is said to have leaped into the burning crater of Aetna so that his death might mystify his followers and lead them to believe him of divine origin. He died about 430 B.C.

EMPHYSEMA, dilatation of the air-sacs or alveoli of the lungs, inducing bronchitis and embarrassment of the respiration.

The condition develops in persons who have a chronic cough, or asthma, or are engaged in an occupation such as playing a wind instrument or glass-blowing. The frequent increase of pressure in the lungs of such subjects distends the thin-walled air-sacs and weakens them. As a result, some of them burst, and a number of contiguous alveoli become confluent. The gas-absorbing surface of the lungs is reduced thereby and the patient must breathe more actively to compensate for the loss. As a result of his constant inspiratory efforts, the chest becomes fixed in a position of inspiration, which increases the difficulty. The size of the capillary bed of the lungs is reduced proportionally to the decrease in alveolar surface and the circulation of blood through the lungs is thereby embarrassed. Thus the right ventricle enlarges (*see* HEART; VASCULAR SYSTEM).

Emphysematous patients get out of wind easily and accordingly must lead a quiet life. Bronchitis and cough follow and aggravate the situation by causing further cavitation.

Treatment of the bronchitis or asthma causing or resulting from the emphysema, change of occupation, and moving to a dry sea-level climate are the best measures.

EMPIRE, a term loosely used to signify a state, large in size, composed of several dissimilar peoples. These two concepts, size and heterogeneity of population, seem to be inherent in the term. Although the

government of an empire is often in the hands of an emperor, such is not necessarily the case. The British Empire, for example, is ruled in theory by a king, in fact by the English Cabinet. The word may be applied to a Federal state such as was Germany, a unified country of broad geographical expanse, as for example Russia before the World War, or even to a league of free states such as compose the British Empire of today.

EMPIRE STATE BUILDING, a 102-story office building, located in New York City on 5th Ave. and 34th St. on the former site of the Astor mansions and the Waldorf-Astoria Hotel. It was opened on May 1, 1931, by Alfred E. Smith, one of the directors, as the tallest structure in the world, extending 1,248 ft. or nearly one fourth of a mile, to the top of the mooring mast. The building, designed by Shreve, Lamb & Harmon, architects, is set in bed rock on 2 acres of land and was constructed in 20 months. Only the first 5 floors cover the entire ground space; there is a 60 ft. terrace set-back from which the tower rises.

The building material consisted of 60,000 tons of steel for the frame, 10,000,000 bricks, and 200,000 cu. ft. of stone. Indiana limestone and chrome-nickel steel are used in the exterior masonry. Flat plates of dull silver aluminum are placed between the top of each window and the sill of the window above, blending with the glass and making all lines vertical. Observation towers are on the 86th and 102nd floors. A mooring mast for dirigibles tops the building. More than 25,000 tenants can be accommodated.

EMPIRE STYLE, in architecture and the decorative arts, the style which characterized the reign of Napoleon 1st in France. In architecture, furniture, even in women's fashions, the Empire style sought the actual recreation of Roman forms, as far as the knowledge of the time and the practical exigencies of early 19th century living permitted. As far as he could Napoleon cleverly capitalized the Roman enthusiasm of the time, making his court and its physical surroundings as Roman as possible. In architecture the style varies from sterile and academic imitations of Roman work, often impressive from their brute size and scale, to creative designs full of the true Roman greatness of scale and structure. In the decorative arts, largely through the influence of Percier and Fontaine, the style is marked by richness, dignity and occasional heaviness. Furniture is simple in line, with much use of cast brass mountings based on Roman details. Textiles often have rich garlanded borders and are dotted all over with the bee or the crowned N of Napoleon. In women's fashions the waist line was high, the breasts much accented. The skirts were loose and straight so as to emulate as far as possible the effects of the drapery on classic statues. *See* ARCHITECTURE, HISTORY OF; MODERN ARCHITECTURE.

EMPIRICISM, a school of philosophy holding that knowledge is derived from experience. It uses sensory criteria as the ultimate test of truth. Empiricism is

usually considered as an opposing philosophy to RATIONALISM. In modern thought the empirical movement found its best expression in England during the 17th century. JOHN LOCKE, GEORGE BERKELEY and DAVID HUME, the great British triumvirate, were the leading empiricists of the period. The development of modern science is closely allied with empirical methods of procedure.

EMPLOYEE, one engaged in the service of another, his employer, for pecuniary consideration. In large industrial concerns, the employees are generally taken as the members of the laboring element as differentiated from the management. With the advent of the factory the status of the employee became such that he was little more than a name or number appearing on the payroll. To alleviate this situation personnel departments have been developed to act as a personal connecting link between the management and the employees. Employee representation has been adopted so that the management may obtain a contact with the employees in matters of mutual interest. Stock ownership plans offer the employees an opportunity to purchase stock of their company and tend to make them take more interest in their work. Employment insurance is a step toward affording a continuous income, and stock ownership, employment savings plans and retirement pensions are being adopted to provide for employees after age renders them unfit for work. *See also* EMPLOYMENT EXCHANGE.

EMPLOYEE REPRESENTATION, the name given to various types of procedure by means of which employees in a business deal with the management through some form of organized group action. Two broad general kinds of plan are to be noted both in point of structure and in point of objective or function. Divided structurally, there are plans in which delegates are elected by the workers on some departmental basis of representation and these delegates meet at more or less regular intervals with an equal number, or equal voting strength, of management representatives. And there are plans in which all the employees who have been with the company a stipulated length of time constitute *ipso facto* a cooperative association or company brotherhood or employees' association or some similar name, and deliberate together largely through an elected executive committee and a group of special *ad hoc* committees. Under this latter kind of organization the rigid distinction between worker and management representatives largely breaks down except as it is deliberately maintained on committees which consider such controversial questions as wages and on which an equal representation of both interests is deemed advisable.

Considered functionally, employee representation plans divide between those that have an explicit power to negotiate terms of employment, notably wages, hours and production standards, and those which only offer suggestions, information and advice to the management.

The terminology of the subject is by no means standardized. There is, however, general agreement

that where the group action by the employees is conducted through an organization of workers that embraces those from numerous companies, whether on a craft or industrial basis, this should be called COLLECTIVE BARGAINING; and the instrument containing the specified terms of employment is a collective agreement. In such cases the initiative in organizing the workers and in conducting negotiations with employers has typically come from the workers themselves through a labor union. Employee representation in all its forms, almost always owes its inception to the initiative of the management of a single company and employee membership does not extend beyond the employees of that company. Shop committees, works councils, company unions are some of the other names by which plans of employee representation are known.

The history of this method of dealing with employees is a short one in the United States, the earliest of such plans being established in 1898. The World War accelerated the formation of these plans and the post-war period has witnessed a remarkable development. Reliable estimates show that about 1,600,000 workers now participate in such arrangements; and that 400 companies with 875 different plants have them in active operation. A few companies have abandoned these arrangements after a short time. But the general trend has been toward their extension to more and more companies and toward allowing the negotiative powers of such groups to be extended and strengthened as time goes on.

While the motives for the introduction of all such plans are no doubt mixed, the general experience is that they offer an effective way to articulate employee opinion and sentiment, to interpret management policy to workers, to act as an organized channel of joint deliberation between managers and workers on a great variety of common problems. They have thus proved themselves a force for stabilization of personnel relations, for improved morale, for quicker and more understanding dealings between companies and their employees, for education of workers in specific business and economic problems.

To some extent the employee representation movement has been felt by the forces of organized labor to constitute a competitive form of organization, designed to forestall and preclude labor union activity and the necessity for collective bargaining. On the other hand two facts stand out. Employee representation exists in numerous companies and industries where LABOR ORGANIZATION as such had never previously been strong or active. And in some of the best collective bargaining arrangements provision is definitely made for intrashop organizations which are designed to fulfill several of the functions also carried on in employee representation plans. There is some force, however, in the objection that employees may not feel that they have as much freedom of expression or as much strength of negotiative power under employee representation plans, as in those methods of collective dealing under which their own paid spokes-

men act for them and there stands in the background the financial power of a national organization of workers in related occupations.

Whatever future developments may be as to the relation of these two broadly different types of organized dealings, it is clear that functionally and structurally viewed there is place for an organization of workers within companies and there is a place for an organization of workers by industries or trades. The trend is clearly toward the development of some genuine constitutional form of organized relationship between those who manage and those who are managed in industry. *See also* PERSONNEL MANAGEMENT.

O. T.

EMPLOYEES, TRAINING OF. *See* PERSONNEL MANAGEMENT.

EMPLOYEE STOCK OWNERSHIP, refers to the purchase of company stock by its own employees by means of various methods of making such purchase attractive on special and preferred terms. It usually implies some one or all of the following features: an instalment payment plan, special price concession, additional contribution by the company, stipulated repurchase arrangement, bonus or special advantages to those who hold their stock continuously. Different plans contain different provisions as to the kind of stock sold. In some cases a special employee stock is issued; in some cases the regular COMMON STOCK is sold; in some PREFERRED STOCK; and in a few cases the money saved is applied to the purchase of securities in what is in effect an INVESTMENT TRUST which owns securities of the company itself as well as other carefully chosen companies.

This development has largely taken place since the World War. Reliable estimates indicate that in 1931 there were over 1,000,000 employees of approximately 300 business corporations who held a total of well over \$1,000,000,000 worth of securities in their own companies. It is impossible to distinguish what proportion of these holdings is in the hands of executives and how much in the hands of rank and file workers.

Several objectives have prompted this development. It has been part of a vigorous thrift campaign; it has been hoped that it would reduce LABOR TURNOVER, that it would supply a back-log for workers' old age, that it would give workers a sense of ownership and participation in their company's success. While it may be too early to estimate the success of this procedure in realizing these aims, it is true that the majority of the companies which have sold stock are continuing to do so and went to considerable lengths in the 1929-31 depression to make it unnecessary for employees to sell their holdings at a loss.

That this development has its own peculiar risks and dangers, is obvious. And as an integral part of a general personnel policy, it can only succeed under circumstances of corporate fiscal and personnel policy which can as yet hardly be called typical in American corporations. Indeed, security ownership for employees makes the following tacit assumptions,—will- ingness and ability of employees to take a risk; a

lessened mobility of investment in the face of what may be shifting economic trends and consumer demands; a lesser diversification of investment than is usually thought wise.

On the other hand, under proper restrictions, it offers a relatively simple and legally acceptable method of employee participation in ownership and income. And where the financial strength and stability of a company are great, the influence of employee stock ownership on morale seems to have been wholly salutary.

O. T.

EMPLOYERS' ASSOCIATIONS, organizations composed of business concerns, or of individuals engaged in the conduct of business enterprises, and created for the discussion of common problems or the promotion of mutual interests. Such associations may be classified as general business organizations which include within their membership representatives of unrelated businesses; organizations in which membership is ordinarily limited to the producers, or the distributors, or both, of a particular product or generic class of products. The latter type is usually referred to when the term TRADE ASSOCIATION is used.

The scope of activity of a general business organization may be broad, as in the case of the National Association of Manufacturers, or restricted to a particular field, as in the case of the League for Industrial Rights. In either case the basic purpose of the organization is usually related to the promotion and protection of the interests of members in their relations with government and with labor. Similar functions are exercised by the various state and local bodies which correspond to the national business organizations. Certain individual associations within this class, however, have been formed for more specific purposes, as for example, the National Industrial Conference Board, which is primarily the economic research organization of American industry.

The activities of a trade association are determined largely by the peculiar conditions of the industry within which it operates and by the extent to which the membership of the association represents the enterprises engaged in that industry. In recent years, the collection and dissemination of statistical data relating to production, sales, prices, shipments, stock on hand, and so on, has become the most general type of trade association activity. Supplementary activities include arrangements for the interchange of patent rights, the compilation of information in relation to the credit of customers, STANDARDIZATION of products, the elevation of competitive standards, commercial and industrial research, cooperative advertising, commercial arbitration, and the improvement of employment relations. In some instances, a special division or bureau, or even a separate association, is created for the purpose of carrying on one or more of these minor activities. In so far as the methods employed in any field of activity furnish evidence of an attempt on the part of any trade association to fix prices, to control production, or to encourage Boy-cotts of non-members, the association may be liable

to prosecution under the Federal antitrust laws, provided such interference with free competition extends to interstate commerce.

The National Industrial Conference Board estimated the number of trade associations of national or interstate character in 1925 at between 800 and 1,000. It is probable that there are now at least 2,000 such associations. M. A.

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EMPLOYERS' LIABILITY. See WORKMEN'S COMPENSATION.

EMPLOYMENT. See EMPLOYMENT EXCHANGE; UNEMPLOYMENT.

EMPLOYMENT EXCHANGE, Employment, Labor or Placement Agency, an organized medium for aiding employers to secure qualified employees and persons seeking work to secure suitable employment. It may be classified as, public, maintained by local, state or Federal authorities, both alone and in conjunction with one another, no fee being charged to either employer or employee; private, maintained by one or more individuals or private interests for profit, a fee being charged to either employer or employee or both; and other exchanges maintained by a variety of organizations for the benefit usually of their members or clients; some charge a fee, others do not.

The primary function of any employment exchange is the securing of opportunities for employment, the recording of specifications respecting them and the registering of the qualifications of applicants with a view to placing those who are suitable. An inherent part of this function is the giving of vocational counsel. It is an additional function of the public employment exchanges in countries which have adopted a national scheme of unemployment insurance to assist in its administration.

The scope of the work of employment exchanges varies considerably. Among the private and other exchanges, service is usually restricted to one locality and to applicants of a particular sex, age, industry, occupation, race, religion, physical disability or some other special characteristic. The public exchanges, on the other hand, extend their service to persons of both sexes and all occupations, and operate not only locally but in a number of instances nationally and internationally.

In the United States the private and other employment exchanges have antedated and greatly outnumbered those supported by public funds. But prior to 1914 a number of municipalities and states had established public exchanges. On the whole, these were meagerly financed and inadequately staffed and were without any system of interoffice clearance of unfilled orders and unplaced applicants.

Following the outbreak of the World War in 1914, the Federal Government, in order to meet the labor demands of war-time production, entered into co-operation with the various states and municipalities for the rapid development of a nation-wide public

employment service. At the height of its development early in 1919 this service consisted of 854 offices with an appropriation of over \$5,500,000. Subsequently, in Mar. 1919 and later in Oct., the Federal appropriation was greatly reduced, and the service curtailed accordingly. Since then, the Federal Government has maintained a mere skeleton organization which, as the United States Employment Service, operates no direct placement offices except those for veterans and farm labor in certain agricultural areas, but rather assists in the coordination of existing state, municipal and some of the other employment exchanges.

Of particular significance has been the development of public employment office laboratories or demonstrations. It is the purpose of these to study the various problems entailed in the operation of a local public employment office, with a view to improving their respective state employment services by incorporating in their practice those methods which experiment has proved to be most satisfactory.

Of foreign countries, 24 of the 55 nations which are members of the International Labor Organization have ratified the convention providing for the establishment of a system of free public employment agencies under the control of a central authority. Other countries which have not ratified this convention also operate systems of public employment exchanges. F. P.

EMPORIA, a city in eastern Kansas, the county seat of Lyon Co., situated on the Cottonwood and Neosho rivers, 70 mi. southwest of Topeka. Two railroads and bus lines serve the city. The region produces grain and livestock and there are oil fields in the vicinity. In 1929 the value of the factory output was about \$1,000,000; the local retail trade reached a total of \$11,292,296. Emporia is a shipping point and educational center; it is the seat of Kansas State Teachers' College, with a student body of more than 5,000, and the College of Emporia with about 350 students. William Allen White, editor of the *Emporia Gazette*, lives here. Emporia was founded in 1856, and incorporated in 1870. Pop. 1920, 11,273; 1930, 14,067.

EMPORIA, COLLEGE OF, at Emporia, Kan., a coeducational institution under the control of the Presbyterian Synod of Kansas, was founded in 1882. The productive funds in 1931 totaled \$575,196. Anderson Library, with 19,000 volumes exclusive of government documents, contains the George W. Martin Kansasana Collection and the William S. Culbertson Drama Collection. In 1931-32 there were 339 students and a faculty of 33, headed by Pres. John Bailey Kelly.

EMULSIONS, mixtures consisting of dispersions of minute drops of one liquid in another. Violent mechanical agitation of two immiscible liquids in the same vessel produces a temporary emulsion but, unless a third substance (the "emulsifying agent") capable of forming a film around the drops is present, the drops soon coalesce into a layer and the emulsion "breaks." It must be admitted that two such liquids may be boiled together without an emulsifying agent to secure an emulsion, often very stable, like the con-

dense-water from an engine, but if the drops occupy more than one per cent of the total volume the emulsion soon breaks. In condenser-water emulsions, and their like, stability is secured by the difference in potential at the interface between the two liquids (around the surface of each drop), in other words, by the electric charge on the drops.

The lower the interfacial tension between the two liquids the easier it is to make and keep their emulsions. Hence the value of certain soaps (*see SOAP*) as emulsifying agents. Some of them greatly lower the interfacial tension between water and some other liquids, yet after all, their more important function is the formation of tough, elastic films around the drops. Other well-known agents are **PROTEINS** (especially in slightly acid or basic solution) and very fine-grained precipitates.

It is the custom to refer to any liquid immiscible with water as the "oil" and to speak of the more common type of emulsion as "oil-in-water," meaning that the droplets or dispersed phase are of oil and that water is the continuous phase. Obviously when droplets of water are dispersed in oil we have a "water-in-oil" emulsion. In general the type can be determined by a proper choice of emulsifying agent. Alkali soaps and other film-formers colloiddally (*see COLLOIDS*) dispersed in water compel the oil to take the drop form while heavy metal soaps, dammar gum, and film-formers colloiddally dispersed or soluble in oil, force the water to take the drop form upon agitation.

Breaking of emulsions is secured by addition of an agent tending to make the opposite type or by addition of chemicals that convert the film-former into less effective compounds. Creaming (a concentration of drops at the top or bottom according to density difference) occurs slowly on standing or more rapidly on centrifuging, unless the drops are extraordinarily small. Homogenized milk fails to cream for this reason.

H. N. H.

ENAMEL, a kind of glass composed of silica, minium and potash, colored with metallic oxides, which is applied by fusion to metal, glass, pottery and porcelain for ornamentation, protection or as a base for decoration. The principal kinds of enamel used in jewelry are **CLOISONNÉ** and *champlevé*; an enamel glaze, for earthenware and *émail de Limoges* are used in the making of chinaware. Enamel decoration was one of the early arts of civilized peoples. In the palaces of ancient Egypt and Babylonia whole apartments were decorated with enamel bricks of a wonderful luster and clearness. The Chinese and Byzantines were the ancient master craftsmen in cloisonné enamel. Ecclesiastical objects of exquisite *champlevé* enamel were made by the Celtic tribes, notably the Irish, in the Middle Ages.

ENCAUSTIC PAINTING, the application, literally the "burning in" of color with wax. The method was successfully practiced by the Greeks, mainly in architecture and in the making of polychrome sculpture, and also by the Romans and Egyptians. The great virtue of encaustic painting is its durability.

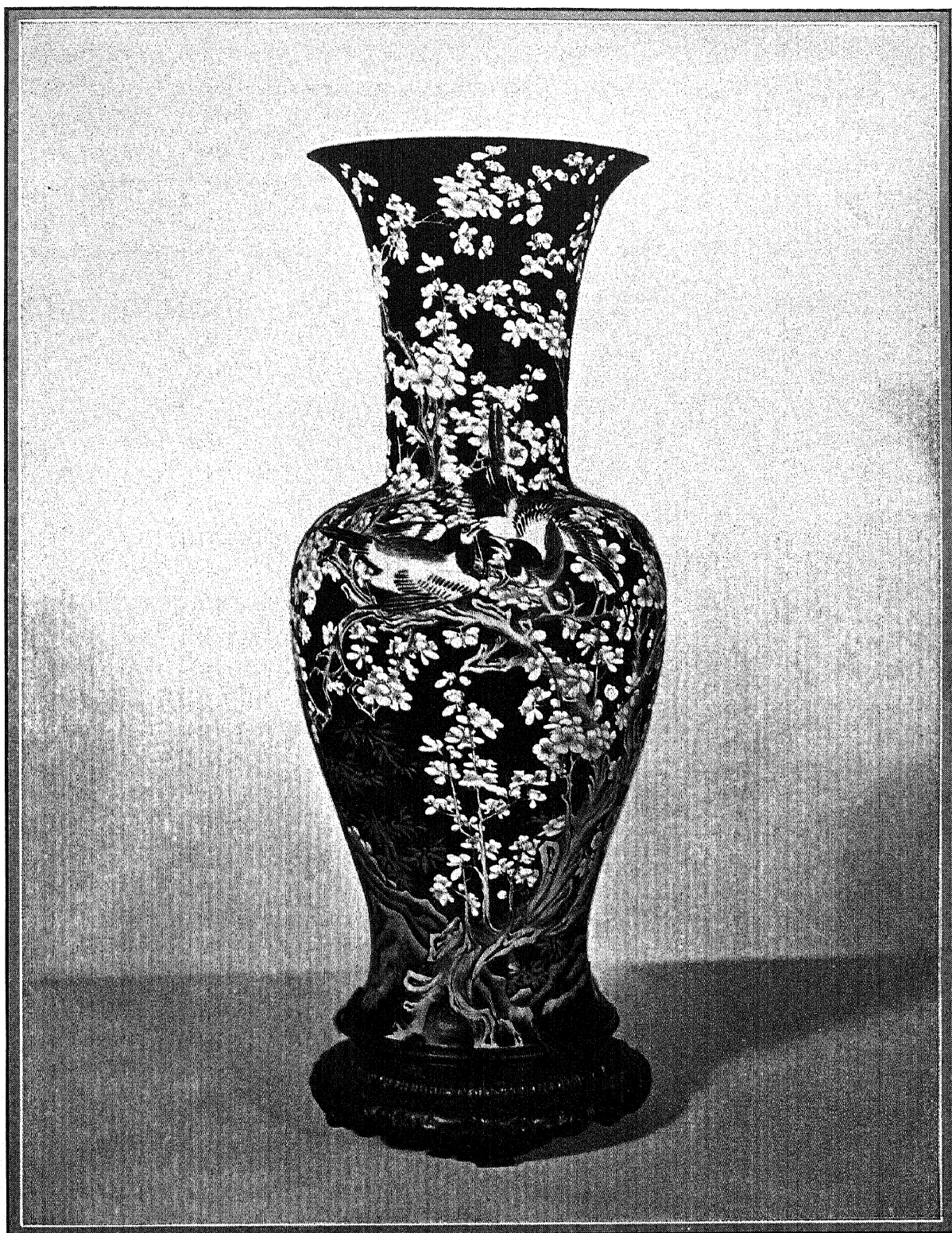
Pliny mentions three kinds of encaustic painting: the houses of Herculaneum and Pompeii were painted by one of these methods, and another took the name of "ship-painting" because its ships were painted in this way. Modern encaustic painting goes back chiefly to a number of experiments made in the 18th century to determine the best method of applying the protecting admixture of wax; those of Mrs. Hooker (Emma Jane Greenland) of Rottingdean, England, were especially successful. The paintings by J. von K. Schnorr in the Royal Palace at Munich, done in 1825, under the patronage of King Ludwig I, are the best-known modern examples of encaustic painting. Schnorr's method differed slightly from Mrs. Hooker's. It is not now a popular medium, but experiment has shown that the use of wax is quite feasible, and the work is technically less difficult than fresco painting.

ENCELADUS, in Greek mythology, son of TARTARUS and GAEA, was a 100-headed giant who made war on the gods. ZEUS struck him with a thunderbolt and chained him under Mt. Aetna. Earthquakes were supposed to be due to his efforts to get out, and the volcanic eruptions were his breath.

ENCEPHALITIS LETHARGICA, meaning inflammation of the brain in general, regardless of the cause. It is also called epidemic encephalitis and "sleeping sickness." The term "encephalitis lethargica" was applied in 1917 by C. von Economo to an epidemic infectious disease which had just appeared in Eastern Europe and rapidly spread all over the earth. As influenza was epidemic at the same time, the independent nature of the "new" disease was not at once recognized, but is now universally accepted. It is probably identical with the "nona" which followed in the wake of the great influenza epidemic of 1891-92 and with variously named epidemic "sleeping sicknesses" which have occurred from time to time for hundreds of years. However, "nona" was very mild compared with the recent disease, and, from available descriptions of older epidemics, it appears that the disease has never before been so severe, so widespread, or so manifold in its manifestations. (*See INFLUENZA.*)

The disease is clearly infectious, but only mildly contagious. It must be due to some microorganism, but, in spite of intensive search by able bacteriologists, the causative organism has so far escaped detection, a fact which has led to the suspicion that it is ultra-microscopic, i.e., too small to be seen with our best present day microscopes. In nearly all cases there is an acute stage, with fever, somnolence, double vision, and often trembling, jerking, or stiffness of the muscles. Headache and other pain, convulsions, and paralysis of the extremities are not usual features, which fact helps to differentiate this disease from the other two common acute infections of the nervous system, namely, **MENINGITIS** ("brain fever") and acute poliomyelitis (**INFANTILE PARALYSIS**). While the last-named disease occurs mostly in children and during summer and autumn, lethargic encephalitis affects children and adults alike and is more prevalent in

ENAMEL



COURTESY METROPOLITAN MUSEUM OF ART

CHINESE VASE OF ENAMELLED PORCELAIN

Vase of the K'ang-Hsi Period (1662-1722). This type of enameled porcelain is known as *Famille Noire* because of the black background upon which the design appears in lighter colors.

winter and spring. In the beginning of the last epidemic, the death rate in the acute stage was high, about 25%, but it gradually has become lower.

Those who survive the acute stage may recover entirely, pass directly into a chronic stage, or develop the symptoms of the chronic stage after a normal interval of a few months or years. It is not unusual for this normal interval to be as long as three years. In adults the usual symptoms of the chronic stage are trembling, stiffness of the muscles, mask-like facial expression, stooped attitude, and slowness of all movements, the whole picture closely resembling a chronic disease known as paralysis agitans, Parkinson's disease, or "shaking palsy." There may be coarse jerkings of different muscle groups, drooling of saliva, indistinct speech and mental disturbance. However, mental disturbances are much more frequent in children and usually in the form of troublesome behavior disorders, rather than simple mental failure or any set form of insanity. The chronic stage is likely to last many years, as, unlike the acute stage, the disease is not likely to be the direct cause of death which usually is caused by intercurrent affection.

Treatment at all stages has to be directed to the relief of symptoms as they appear, as no specific remedy has been discovered. See also MEASLES.

P. BA.

ENCHANTED MESA, a precipitous mesa or butte of buff sandstone 2,000 ft. long and from 100 to 300 ft. wide, rising 430 ft. above the Acoma basin in Valencia Co., New Mexico. The Enchanted Mesa is approximately 3 mi. northeast of Acoma Mesa. The mesa is called Katyzimo by the Indians and according to their traditions it was the site of a prehistoric village of that name which was at one time inhabited by ancestors of the present dwellers on Acoma. The tradition relates that during a terrific storm the rope ladder approach to the summit was destroyed. Three women were marooned on top, doomed to starvation and the rest of the village moved to Acoma. The rock was first scaled in modern times in 1897 by Adolph Baudelier representing the Bureau of American Ethnology. He discovered faint traces of human habitation, substantiating the Indian tradition.

ENCINA, JUAN DEL (c. 1469-c. 1530), Spanish poet, was born at Encina, Salamanca, in 1469. He studied at the University of Salamanca, and entered the Duke of Alba's service in 1493. Protected during his stay in Italy by Pope Alexander VI, he subsequently took orders, singing his first mass at Jerusalem in 1519, and becoming Prior of the Leon Monastery. Encina wrote many beautiful lyrics, composing musical settings for 80 of them. His 14 plays, or eclogues, are technically admirable, and show real poetic feeling. Encina has been called "the father of the Spanish theater." He died at Salamanca about 1534.

ENCKE, JOHANN FRANZ (1791-1865), German astronomer, was born at Hamburg, Sept. 23, 1791. After studying under Gauss at the University of Göttingen he joined the staff of the observatory of Seeberg

near Gotha, where as director in 1822 he issued a new star map. Working on observations of the transit of Venus made between 1761 and 1769 he accomplished the first reliable work on the parallax of the sun. This enabled him to compute the earliest accurate figure of the distance to the sun. In 1825 he became astronomer of the Academy of Sciences and director of the new Berlin Observatory. From his computation of its extremely small orbit (3½ year period) the comet of 1818 was named for him. He died at Spandau, Aug. 26, 1865.

ENCLAVE, an area of land inclosed within a foreign state or a portion of territory completely surrounded by the territory of another state. It is also regarded as a colony or dependency of a country which is surrounded by the land of a foreign state or is exclusively an interior region entirely enclosed by the land of a foreign state. Anhalt, Brunswick and Lippe are enclaves within Prussia.

ENCLITIC, a word which has no accent, or at most, only a secondary accent, of its own, as Latin *que*, "and," in *arma virumque cano*, "arms and the man I sing," an English example being the COPULA, as *the man is evil*. In INDO-EUROPEAN the verb in an independent clause was enclitic unless beginning the clause, as is still the case in SANSKRIT, with marked traces in GREEK and LATIN verse, this being one of the reasons why the verb seems to be of later development than the noun. Similarly, there is reason to believe that all cases of the noun except the nominative and accusative were originally enclitic.

A word with no accent of its own which precedes a word with independent accent is termed "proclitic," this being apparently the case with the verb in primitive SEMITIC.

ENCLOSURE, the bringing together of strips of arable, waste, forest or fen land within a fence or hedge. Enclosure occurred first on the holdings of the lord and the more prosperous peasants, and then on the lands of small cultivators. Movements to enclose the open fields took place in practically every European country at times varying from the 16th to the 19th century. Enclosure assisted scientific farming, and enabled attention to be paid to the proper rotation of crops, FERTILIZATION and CATTLE RAISING. The English enclosure movement may be taken as typical. There, with the increase in sheep-raising, the process began in the 16th century. It continued in the 17th century, and in the 18th was accelerated. The early enclosures were mostly of arable land, the later enclosures of commons and waste. Both the 16th and 18th century enclosures caused contemporary outcry as a movement that dispossessed the agricultural laborer and depopulated the land. By the end of the 18th century England was almost entirely enclosed. In Denmark and southern Sweden, similar enclosure movements occurred in the 18th century. France underwent no enclosure movement as such, although some parts had always been enclosed with the usual accompaniment of agricultural improvement. The open field system was still prevalent in the German

provinces in the early 19th century. The Prussian development, representative of the other provinces, exhibits both legal and agricultural reform in the 19th century. The PEASANT was emancipated, and the fields were enclosed.

Although inevitable with the development of scientific farming, enclosure was frequently carried out with little regard for the rights of small holders and laborers. It was accompanied, particularly in England, by real distress and by a shift of the agricultural population to the cities. Some historians think this distress exaggerated by contemporary accounts, but there is no doubt that much existed. The enclosure of commons, as in 18th century England and 19th century Prussia, aroused great opposition, as the agricultural laborer was thereby deprived of hereditary rights, and prevented from keeping live stock. The difficulty was that enclosure was usually brought about by large landowners who pushed it through with only their own interests in mind, and without regard to the minority interests of small farmers or cottagers.

E. W. G.

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ENCLOSURE ACTS, measures rearranging and enclosing the common fields. Such acts were passed in England as early as the reign of James I, but this method was seldom used until the latter half of the eighteenth century. Previously ENCLOSURE took place by private agreement. These early enclosure acts were private bills, presented for parliamentary approval by the landowners concerned. They received parliamentary sanction when four-fifths of the commoners, the lord of the manor, and the tithe-owner agreed upon the provisions. This method was expensive and liable to abuse. In 1801 a general Enclosure Act was passed, setting forth rules for enclosure which obtained unless special acts specified to the contrary. Private enclosure bills were not eliminated until 1845.

E. W. G.

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ENCOMIENDA. See LATIN AMERICA.

ENCYCLICAL, an ecclesiastical term signifying a pronouncement of the pope on some public question, religious or secular. An encyclical is written in Latin and, for purposes of reference, is identified, like other papal documents, by its first words. The encyclicals of Pope Pius XI, dealing with education, marriage, divorce and birth control, industry, socialism and other problems, have been translated into many languages and widely published.

ENCYCLOPEDIA, a term compounded of the Greek *enkyklios*, meaning circular or complete, and *paideia*, instruction, to mean the complete circle of learning, and first used as the title of a series of books in the 16th century.

The oldest extant example of an encyclopedia is Pliny's *Natural History*, written before 79 A.D., which consists of 37 books and 2,493 chapters. Four promi-

nent later examples are the encyclopedia in prose and verse by Martianus Minneus Felix Capella (5th century), the *Etymologiarum libri XX* or *Origines* by Isidore, Bishop of Seville (7th century), the *De Universo* by Hrabanus Maurus, Archbishop of Mainz (9th century) and the *Speculum Majus* or *Bibliotheca Mundi* by Vincent of Beauvais (13th century).

The first important modern encyclopedia was Johann Heinrich Alsted's *Encyclopaedia septem tomis distincta*, 1630, and the first alphabetically arranged encyclopedia in a modern language was the Italian *Biblioteca universale sacro-profano* by Vincenzo Maria Coronelli (1701-06). The *Grand Dictionnaire* of Louis Manéri (d. 1680) was really an encyclopedia, important in itself and also for having inspired Pierre Bayle's noted *Dictionnaire historique et critique*, 1697. In English the first alphabetical encyclopedia was the Rev. John Harris's *Lexicon Technicum*, 1704. In 1728 Ephraim Chambers published his excellent *Cyclopaedia* or *Universal Dictionary of Arts and Sciences*. Also notable in the 18th century were Zedler's *Universal Lexicon*, 1732-50, the great work of the French ENCYCLOPEDISTS and the *Encyclopaedia Britannica*, Edinburgh, 1768.

The 19th century produced the following encyclopedias: in France the *Grande Encyclopédie* and the encyclopedic dictionaries of Larousse and Littré; in Germany the *Konversations-Lexicon* of Brockhaus and of Meyer; in Italy the *Nuova Enciclopedia Italiana*; Spain, the *Diccionario enciclopédico Hispano-Americano*; England, Charles Knight's *Penny Encyclopaedia*, *The English Encyclopaedia* and others. In the United States: the *New American Cyclopaedia*, 1858-63, Johnson's *Universal Cyclopaedia*, 1893-95, the *Americana*, 1839-47, and the *International Encyclopedia*, 1884.

ENCYCLOPEDISTS, the group of French intellectuals who published in 1751-1772 the *Encyclopédie ou dictionnaire raisonné des sciences, des arts, et des métiers*, based on John Mills's French translation of Chambers's *Cyclopaedia*. DENNIS DIDEROT (1713-84), much persecuted for his avowed scepticism, was editor-in-chief of the work, though almost as conspicuous was d'Alembert (1717-83), who wrote the mathematical articles and the remarkable *Preface*. Among the others may be noted d'Argenville, Mallet, Dautenton, Rousseau, La Chapelle, Louis and Blondel.

ENDEMISM, a term used in biology to indicate the natural restriction of a group of plants or animals to a geographically limited area. Thus the kangaroos are endemic to Australia; the big tree is endemic to the Sierra Nevada Mountains of California. The term may be, and often is, used for restriction to a political region, but is applied preferably and with greater significance to restriction in an area delimited from its surroundings by differences in environment or geological history or separated from other areas by evident barriers to free migration. The last is particularly noteworthy in oceanic islands whose remoteness from other lands effectually prevents migration of animals and plants.

In general, endemic species are of two sorts, relict and recent. Recent endemics are of comparatively late origin and have not spread beyond their locus of evolution, either because of environmental barriers to migration or because of lack of time since their appearance. Relict endemics represent the last survivors of a group of formerly wider distribution, now restricted to a limited region by the vicissitudes of geological or climatic changes. The assignment of an endemic group to either type depends on a knowledge of its immediate relatives, both living and fossil. Thus the history of the elephants and the sequoia trees shows that both were formerly large groups of wide distribution and indicates that the few existing species are relict endemics, while the numerous species of hawthorn in the eastern United States and of pocket-gophers and chipmunks in the western states are examples of endemism due to recent evolution. Endemism in correlation with geological history is often of great value in determining the source and route of biotic migrations and the age of biological groups.

H. A. G.

ENDERBY LAND, an antarctic region in $66^{\circ} 25'$ South lat., $49^{\circ} 18'$ East long., named by the whaler John Biscoe in 1831 in honor of his employer, Samuel Enderby, an adventurous London merchant. The region is a headland, thought to be a part of the antarctic continent, but it has never been revisited.

ENDICOTT, JOHN (1589-1665), colonial Governor of Massachusetts, was born at Dorchester, England, in 1589. After serving as Deputy-Governor of Massachusetts, he was chosen Governor in 1644. Except for a period between 1650 and 1654 he held this office continuously from 1649 until his death. His administration was marked by strict enforcement of the Puritan laws. Endicott died in 1665.

ENDICOTT, a village in Broome Co., southern New York, situated on the Susquehanna River, 7 mi. west of Binghamton. It is served by the Erie Railroad and by river craft. The village has an important shoe industry. Leather products, clocks, metal forgings and tabulating machines are also manufactured here. The retail trade in 1929 amounted to \$7,841,831. Diversified farming is carried on in the district, grain and potatoes being the chief crops. The villages of Union and Endicott were consolidated as Endicott in 1921. Pop. 1920, 9,500; combined with Union, 12,803; 1930, 16,231.

ENDIVE (*Cichorium Endivia*), an annual or biennial herb of the composite family closely allied to the CHICORY. It is probably a native of India and has been cultivated since ancient times. The plant bears rosettes composed of numerous oblong, cut or lobed basal leaves, in some forms finely curled or frizzled, and a branching stem 2 or 3 ft. high with numerous purple flower-heads. When blanched to diminish their bitterness the leaves are used as a salad.

ENDOCARDITIS. See GONORRHEA; HEART DISEASE.

ENDOCRINE GLANDS, or **DUCTLESS GLANDS**, are structures that produce secretions

which are discharged directly into the blood. In general, these glands have several functions. They regulate the body metabolism, that is, the building up and tearing down of tissue; they control the blood pressure and circulation and a number of other important physiological processes. There are a number of glands whose only apparent function is the production of internal secretions. There are others which produce both external and internal secretions.

About fifteen separate glands which produce internal secretions have been enumerated. Some of these are hypothetical, but there can be no doubt that the pancreas, thyroid, parathyroids, adrenals, the pituitary gland and the sex glands produce internal secretions, the last three each producing more than one.

The **THYROID GLAND** is situated at the base of throat. The internal secretion has a controlling effect in regulating the activity of most of the body processes.

The secretion of the inner part of the **ADRENAL GLANDS**, which are located one above each kidney, probably has for its function the prevention of undue relaxation of the arteries, thus maintaining the normal blood pressure. The glands discharge this secretion in large amounts during violent excitement, and the circulation adapts itself to the needs of extreme muscular exertion. Lack of the secretion produced by the outer part of the adrenal glands causes the disorder known as **ADDISON'S DISEASE**.

The **PITUITARY GLAND** is situated at the base of the brain in a depression in the skull. It consists of an anterior and a posterior lobe. It appears that the secretion from the anterior lobe regulates growth, particularly of the skeleton and the sex glands. The secretion from the posterior lobe is concerned in the use of starches and sugars by the body. It also regulates the contraction of the involuntary muscles, like those of the intestine, the womb and the blood vessels.

The secretion of the **PARATHYROID GLANDS**, two small structures located at each side of the thyroid gland, acts in some manner to regulate the use of calcium and phosphorus by the body.

The **PANCREAS** is a thin, elongated organ lying in the abdominal cavity across the vertebral column and just above the level of the navel. Insulin, the internal secretion of the pancreas, is needed to allow the body to use sugar.

The sex glands furnish internal secretions that are responsible for the development of the secondary sexual characteristics, producing the distinguishing body shapes. Falling and greying of the hair, wrinkling of the skin and loss of weight and strength, all of which are signs of age, are believed to be partly dependent upon changes in the internal secretions from the sex glands.

Other glands that possibly have an internal secretion are the **THYMUS** and **PINEAL BODY**. Secretin, a substance secreted by the lining membrane of the upper part of the small intestine stimulates the secretion of the pancreatic juice.

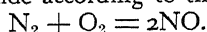
The ductless glands are not independent, but their activities are interrelated. The secretion of each one

influences the secretion from the others. The normal secretion of each gland is essential to health and various diseased conditions are caused by the suppression, the increase or chemical alteration of these secretions. *See also* GLANDS; PYORRHEA. W. I. F.

ENDOLOGY, the name given by anthropologists to the rule which prescribes that an individual must find a mate within his own group, whether that group is the family, village or other social unit. Hindus, for example, may not marry outside their own caste; nobles were once frowned on for marrying commoners and the early Quakers disowned members who married "out of meeting."

ENDORSEMENT. *See* INDORSEMENT.

ENDOTHERMIC REACTIONS, chemical reactions which proceed with the absorption of heat from the surroundings. The effect manifests itself by the fact that the temperature of the system falls as the reaction proceeds, or else heat must be supplied from a suitable source to maintain the temperature at the initial value. An example of an endothermic reaction is the fixation of atmospheric NITROGEN in the form of nitric oxide according to the equation:



In this reaction 43,200 calories of heat are absorbed.

ENDOWMENT INSURANCE, a form of insurance under which the principal sum is paid either at the close of a stated period or at death. It is, therefore, both a life and a death insurance policy and is the insurance contract under which the insured may live to receive the principal of the policy. A pure endowment policy is that form which guarantees the payment of a stated sum on condition that the individual lives to a certain date and in case of death previous to this time the principal sum is not paid. Such policies are now of little significance and the term endowment policy now means a pure endowment policy combined with a term policy. The premium is, therefore, made up of the premium on a pure endowment policy and a term policy for the same period.

Endowment policies are usually written for periods of 15, 20, 25 or 30 years. As in the case of all modified policies of the whole or ordinary life policy, the premium payments may be arranged in almost any form: that is, a single premium may be paid or the premiums may be paid in a limited number of years or they may continue throughout the duration of the policy as an annual, semi-annual, or quarterly premium. Since the endowment policy is a combination of a pure endowment and a term policy the premium for any given age will be higher than that of the ordinary life or a limited payment life. Cash surrender values and loans values are, therefore, higher on this type of a policy. The policy contract does not differ in other respects as regards beneficiary, insurable interest and warranties from that of the ordinary policy contract. W. F. G.

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ENDYMION, in Greek mythology, a beautiful youth loved by DIANA, goddess of the moon. He

is usually described as a sleeping hunter or shepherd on Mt. Latmos. Diana looked down from the sky and, loving him, kissed him with her moonbeams. ZEUS endowed him with perpetual youth and eternal sleep, and Diana watched his flock while he slept. A less widely accepted legend makes him king of Elis.

ENERGY. A body possesses energy when it has the capacity to do WORK. The body may possess this capability of doing work either by virtue of its position or by virtue of its motion. A WATCH spring, when "wound up," is capable of doing work because of the tension produced by its various coils. Until the train of wheels connected with the spring is released, the energy is all *potential energy*, i.e., energy which is stored up and is ready to be released. It has energy potentialities by virtue of its position. The water stored in a mill-pond represents potential energy. The water at the top of Niagara Falls, just before it plunges, is also an illustration of potential energy. As the water plunges to the bottom of the falls, it acquires increasingly greater velocity. Because of its motion, the impact of the water particles on the paddles of a water wheel can cause rotation of the wheel, thus doing work. This capability to do work because of motion is *kinetic energy*.

The potential energy of the water at the top of the falls is equal to its kinetic energy at the bottom. At any point between the bottom and top, the energy consists of both potential and kinetic energy. This follows the theory of the *conservation of energy*, which states that energy can neither be created nor destroyed; it is merely transformed.

The coal which is burned in furnaces and under steam boilers possesses potential energy in the chemical state, stored there many years ago. In the process of burning, this energy is released and is converted into the energy of heat. This heat increases the THERMAL AGITATION of the MOLECULES of water in the boiler, causing the distance between them to increase until the water becomes STEAM. This steam produces pressure, which, when applied to the piston of a STEAM ENGINE, does work. This mechanical energy may be used to drive an ELECTRIC GENERATOR, thus being transformed into electrical energy. The electrical energy, in turn, may be converted into the energy of heat and light, of electromagnetic waves or of CATHODE RAYS.

If the original energy in the coal be measured carefully and compared with the energy transmitted along the line of transformation, it will be seen that the original energy of the coal is just equal to the energy transformed into useful work plus the energy which is dissipated as heat and electromagnetic losses in the various transformations. S. R. W.

ENFIELD GLEN PARK, a park in Tom Co., N.Y., south of Ithaca and Lake Cayuga, created in 1920; area 850 acres. The region is heavily forested and contains a remarkable stand of red pine. An unusual feature is a glen with 12 waterfalls, of which Lucifer, with a 115 ft. drop, is the highest. The

park has swimming pools, camp sites and an extensive system of trails.

ENGAGED COLUMN, in architecture, a decorative or structural form taking the shape of a half or three-quarter column, apparently attached to or engaged in the face of a wall or pier. Engaged columns are frequently built integrally with the wall, but in some cases the use of the lathe in turning columns has led to the construction of the column portion in separate pieces. Engaged columns occur occasionally in Greek work, as in the famous Temple of Zeus at Agrigento, in Sicily, 6th century B.C. In Roman work they are much more common, being used not only as wall decorations but also on piers between arches, as in the Roman theaters and amphitheaters. Engaged columns in Romanesque and Gothic work frequently appear as members of a clustered pier and also as supports for decorative wall arcades.

ENGELBREKT OF SWEDEN (? -1436), Swedish leader under whose leadership the Swedes made the first breach in the state of union between Sweden and Norway. Engelbrekt led the insurrection against Norway in 1434 and was assassinated in 1436. In that year the Swedes elected as their king, Karl Knutsson Bonde, who received the title of Charles VIII of Sweden.

ENGELS, FRIEDRICH (1820-1895), German Socialist, was born at Barmen, Sept. 28, 1820. He became interested in socialism in Berlin, and later while working near Manchester, England, contributed to Chartist and Owenite publications. On a visit to Paris in 1844, he met Karl Marx whose friend and collaborator he became. After the revolutionary outbreak in Baden in 1848, Engels returned to Manchester. In 1870 he settled in London and devoted himself to writing. His outstanding work is *Der Ursprung der Familie, des Privateigentums, und des Staates*. After Marx's death, Engels completed three volumes of Marx's *Das Kapital*. He died in London, Aug. 5, 1895.

ENGHIEN, LOUIS ANTOINE HENRI DE BOURBON CONDÉ, DUC D' (1772-1804), was born at Chantilly, Aug. 2, 1772. Though not yet 20 at the outbreak of war in 1792, he became an officer of the Emigré forces and took part in the Duke of Brunswick's unfortunate invasion of France. After the Peace of Luneville in 1801 he married Charlotte, niece of Cardinal de Rohan, and took up his residence in Baden, near the Rhine. Early in 1804 Napoleon, having heard rumors of his complicity in the Cadoudal-Pichegru conspiracy, ordered his arrest. Accordingly French mounted gendarmes crossed the Rhine, seized him in his home and took him to the castle of Vincennes where he was hastily tried by a military commission. As there was no proof of conspiracy he was accused of having borne arms against France and of intending to do so again. At 2:30 in the morning, Mar. 21, 1804, he was shot in the moat of the castle, near the grave that had been dug before his arrival the evening before. Napoleon had refused to listen to pleas for mercy and cannot be exonerated

from responsibility for the tragic death of the young duke which did much to arouse the public opinion of Europe against him.

ENGINE. Generically all devices producing motion fall under the classification of engine. Consequently, there are engine lathes for turning metal, windlass engines for anchor hoisting, STEAM ENGINES and INTERNAL COMBUSTION ENGINES producing power from steam and combustible fluids, wind engines, or WINDMILLS, and many others. See also DONKEY ENGINE; EXPANSION ENGINE; FIRE ENGINE; LOCOMOTIVE; ROTARY ENGINES; UNIFLOW ENGINES; AIR ENGINES; AUTOMOTIVE ENGINES; GAS ENGINE; NON-EXPANSION ENGINE; OIL ENGINE; RADIAL GASOLINE ENGINE; TURBINES, WATER; TURBINES, STEAM.

ENGINE, AIRCRAFT. See AIRCRAFT ENGINE.

ENGINEER, a person who organizes and directs men and the forces and materials of nature by means of scientific principles and methods. An engineer must have a sound knowledge of the fact and theory of the natural sciences, of materials and machines, as well as an understanding of the uses of wealth, both of nature and of society. There are many classes of engineers, among them being civil, mechanical, chemical, electrical, mining and agricultural. The term engineer as here used refers to the professional engineer, as distinguished from the operator or custodian of an engine, locomotive, machine and instrument.

ENGINEERING, a term applied to the profession concerned with the practical adaptation of scientific knowledge and the forces and materials of nature to the needs of mankind. Engineering was first employed in military operations in the construction of fortifications, roads and bridges. The era of railway building created a demand for engineers in other than a military capacity. To distinguish the men whose profession was that of designing and building civil works from those employed in military engineering, the term "civil" engineering was coined.

Throughout the greater part of the 18th century engineering was confined largely to geographical measurements and the design and construction of canals, railroads, water works, roads, and bridges. In the latter part of the century, however, the machine age had its beginning with the invention of the steam engine and power driven machinery; with it came the profession of mechanical engineering. Mining engineering applies much of the knowledge and methods of civil and mechanical engineering and geology to the operation and development of mines. With the introduction of electricity in industry on a large scale, the profession of electrical engineering was developed to cope with problems of design which were beyond the scope of the mechanical engineer. Likewise, the introduction of multitudes of chemical processes and products into industry gave rise to chemical engineering. The other main division of engineering, agricultural engineering, applies certain phases of the other branches of engineering to scientific farming.

Under each of the main divisions of engineering

there are many specialized divisions. Mechanical engineering includes automotive, aeronautical, ventilating, heating, steam, gas and industrial engineering; civil engineering includes railway, structural, sanitary, hydraulic and highway engineering; electrical engineering includes power generation, power distribution, power transmission, radio, telephone and television. There are hundreds of these special divisions and new ones develop as new fields of scientific knowledge are opened up and as an old field becomes too broad for an individual to master it in detail. The profession of engineering has grown from one comprising a few practical mathematical-minded men to one involving thousands of college graduates and self-educated men. It is to engineering, combined with the productive capacity of capital, that civilization is indebted for its present high standard of living.

ENGINEERING, SCHOOLS OF, institutions of higher education devoted to the teaching of applied science, technology and the several branches of engineering, including civil, mechanical, chemical and electrical engineering and the numerous subdivisions of these main branches. In the United States the first distinct school of engineering was **RENSSELAER POLYTECHNIC INSTITUTE**, established in 1824 at Troy, N.Y., to give instruction in general engineering and especially in the science of agriculture. Rensselaer instituted a course in civil engineering in 1829, and 20 years later attempted still further to broaden its scope after the manner of the *Ecole Centrale des Arts et Manufactures* in Paris, which was in direct contact with all important French industries. Besides Rensselaer, the only other American engineering schools up to the time of the Civil War were the Military Academy at West Point, Lawrence Scientific School at Harvard, established in 1847, Sheffield Scientific School at Yale, also opened in 1847, and the School of Civil Engineering at the University of Michigan, established in 1853. This scant list of pioneer schools was greatly augmented after 1862, when the Morrill Act made possible the founding of many **LAND GRANT COLLEGES**. By 1880 there were 85 schools of engineering in America. In 1917 the United States had 126 engineering schools, of which 46 were land grant institutions, 44 were professional schools in universities, 20 were attached to colleges, and 16 were independent. In 1931 there were 150 American schools of engineering.

The industrial expansion of the past half-century has given tremendous new importance to engineering, and has subdivided its main branches and highly specialized the subdivisions. Schools of engineering have had not only to keep pace with industry in their methods of teaching, but also to cooperate with industry in shop and laboratory work and in their research departments. In general modern schools have balanced their curricula so that in the first two years of a four-year course the student gains a scientific background, concentrating on mathematics, chemistry, physics, mechanics, thermo-dynamics, surveying, and mechanical drawing, and offering also courses

in economics, history, English and one or more foreign languages. In the third and fourth years the student receives technical training in the branch of engineering he prefers. Most schools offer in addition graduate courses, usually of two years.

The first American school to have special shops for the training of its students was Worcester Polytechnic Institute, founded in 1868. In present day engineering schools shop work is now a most important feature. Many schools supplement work in their own shops with field trips to nearby industrial plants. Of great importance also is the Cincinnati Cooperative Plan, instituted in 1907 at the University of Cincinnati. Under this system students divide their time, in bi-weekly or monthly periods, between the university, where they engage in their ordinary studies, and selected industrial plants or factories, where they work as paid employees, gaining first-hand experience.

ENGINEERING DRAWING, a term applied to the different systems of graphical representation used by engineers and draftsmen in designing and describing engineering projects. Most of it is done accurately with drawing instruments, and for this reason it is often designated as mechanical drawing; but technical sketches made freehand are also a form of engineering drawing.

The main purpose of engineering drawings is to indicate the exact shape, size, position and material of the various parts of the machine or structure represented, so that the object can be constructed and its cost estimated. Drawings having this complete information are called working drawings, and are classified as assembly drawings and detail drawings.

In describing the form of an object with three dimensions on a sheet of paper having only two dimensions, the system known as orthographic projection, whose theoretical basis is **DESCRIPTIVE GEOMETRY** is used. Practically, orthographic projection consists of drawing a series of "views" of the object as seen from different positions, including: a front view, or front elevation taken from directly in front and far enough away to assume that all the rays from the eye to the object are parallel; a top view or plan looking from above; and a right or left side view or side elevation. The top view is drawn directly above the front view, and the side views across from the front view. Frequently sectional views, showing the object as if parts were cut away so as to show the interior construction, are required; and sometimes auxiliary views showing the true shape of an inclined or curved face, are needed. Figured dimensions and notes are added according to accepted rules for dimensioning.

Isometric drawing, oblique drawing and cabinet drawing are one-view pictorial systems sometimes used to advantage in making sketches. T. E. F.

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ENGINEERING INDEX, a publication edited by the American Society of Mechanical Engineers as

a guide to all the important technological activities and engineering developments. It lists the technical articles published during the year in all the leading engineering, scientific, technical and trade papers; publications of the engineering, scientific and technical societies; and engineering bulletins of colleges, municipalities, governmental departments, research organizations and the like throughout the world. Each index item gives a brief explanation or description of the article or paper together with the necessary reference data. The items are arranged alphabetically under specific headings. The items may be had on individual cards published daily or in annual volumes. Copies of all the publications listed are kept in the Engineering Societies' Library in New York. The Engineering Index has grown out of Index Notes founded in 1884 by Dr. J. B. Johnson of Washington University, and published monthly in the Journal of the Engineering Association.

ENGINEERING RESEARCH is pure and applied research in the basic sciences underlying engineering. It has undergone a great development during the decade 1920-30. The research work sponsored by industrial organizations, either within their own laboratories or elsewhere, is contributing very materially to the success of these organizations, as well as to the general industrial advance of the country. Those corporations which have failed to support, or are not in a position to support, research are fast falling by the wayside.

According to recent figures from the National Research Council, over 1,600 companies in the United States are supporting research and are employing over 500,000 ENGINEERS and TECHNOLOGISTS. One organization spends over \$19,000,000 annually for research. Among the largest of these laboratories are the ones sponsored by American Telegraph and Telephone Company, General Electric Company, General Motors Corporation, E. I. duPont de Nemours Company, and Aluminum Company of America.

Valuable research work is done in a number of laboratories not directly associated or connected with any one organization. The outstanding laboratory in this field is the Mellon Institute, with most of its work in the field of chemical engineering. Battelle Institute is specializing in metallurgy and fuels. Work of a valuable scientific character is also done by government bureaus, such as the United States Bureau of Standards and the United States Bureau of Mines.

Among the larger universities that have sponsored engineering research activities are, University of Michigan, University of Illinois, Ohio State University, University of Wisconsin, and Massachusetts Institute of Technology. The work at Massachusetts Institute of Technology, Illinois, Purdue, and Michigan has been outstanding because of the extent to which these activities have been supported from the outside.

A. E. WH.

ENGINE TESTING CODE, a set of rules governing the testing of prime movers. These rules specify the method of making the test, the instrument

to be used and methods of calibrating them, as well as other necessary and desirable data.

The demand for a standard method of testing engines led to the formation of the Power Test Code Committee of the American Society of Mechanical Engineers which has prepared a Code that has been accepted by the American Standards Committee as the standard method of making such tests. In England the Institution of Mechanical Engineers has a similar code and in other European countries such codes are either in being or in preparation.

ENGLAND, a division of Great Britain, most of the southern part of the island, separated from Scotland on the north by the Cheviot Hills; from Belgium, Holland, Germany and Denmark by the North Sea; from France by the Straits of Dover, 21 mi. wide; and from Ireland by the Irish Sea. Wales on the west has a land frontier of about 120 mi. Roughly triangular in form, of which the eastern side measures about 350 mi., the southern 325 mi., the western 425. The land frontier on the north is 70 mi. The area is 50,874 sq. mi.

The principal territorial divisions are the 40 counties.

Counties	Population 1921	Population 1931
Bedfordshire	206,462	220,474
Berkshire	202,543	214,181
Buckinghamshire	236,171	271,565
Cambridgeshire ..	129,602	140,004
Cheshire	613,479	675,190
Cornwall	320,705	317,951
Cumberland	220,463	205,790
Derbyshire	583,283	614,926
Devonshire	439,996	458,664
Dorsetshire	224,731	239,347
Durham	917,625	924,050
Essex	920,141	1,198,601
Gloucestershire	328,226	335,801
Hampshire	1,004,918	1,014,115
Herefordshire	113,189	111,755
Hertfordshire	333,195	401,159
Huntingdonshire ..	54,741	56,204
Kent	1,117,929	1,194,115
Lancashire	1,743,824	1,794,857
Leicestershire	260,326	302,683
Lincolnshire	602,202	644,553
Middlesex	1,253,002	1,638,521
Monmouth	450,794	434,821
Norfolk	322,932	321,870
Northamptonshire ..	211,509	217,114
Northumberland	407,317	408,665
Nottinghamshire	378,525	443,880
Oxfordshire	122,325	129,059
Rutlandshire	18,376	17,397
Shropshire	243,062	244,162
Somersetshire	397,022	406,319
Staffordshire	660,852	703,144
Suffolk	211,702	207,420
Surrey	738,711	947,695
Sussex	452,101	500,017
Warwickshire	326,466	365,323
Westmoreland	65,746	65,398
Wiltshire	291,838	303,258
Worcestershire	292,979	310,080
Yorkshire	1,904,456	2,030,702

Surface Features. Lowlands occupy all of England except the Pennines, the lake district and Corn-

wall. The English lowlands are old coastal plains across which, from north to south, run two cuestas with westward-facing escarpments. Thus both topography and soils show a zonal arrangement, the resistant limestone and chalk escarpment belts alternating with the weaker clays which form the back slopes or vales of the cuestas. The western limestone escarpment in the south is known as the Cotswold Hills, in the north, as the Lincoln Heights. Similarly the eastern, a chalk formation, in the south is known locally as East Anglian Heights, while, north of The Wash, it meets the sea at Flamborough Head. To the south of London is the truncated dome formation known as the Weald, with bordering escarpments, the North and South Downs. From the broad area south of the Pennines, the Midlands, extensions of the lowland, run northward on either side of that range. On the west this region opens into Lancashire through the Midland Gate, and on the east it forms the Yorkshire Plains. The Pennines are topographically, though not geologically, a prolongation of the southern uplands of Scotland. Like the latter they separate important industrial areas based chiefly upon the coal found on their flanks. The ridge is an anticlinal fold of sedimentary rock whose upper portions, including the coal layers, have been removed by erosion. The scanty soils are treeless, but support a grass cover extensively used for sheep pasture. Two breaks across the range, the Tyne and Aire gaps, provide important communicating routes between east and west. The lake district in the northwest is a dome-shaped elevation, Scafell 3,210 ft., on the slopes of which lie several long narrow lakes. These have been formed by valley glaciers which dammed several of the stream channels radiating from the central elevation. The beauty of the scenery attracts many visitors, although the rainfall is very heavy, one place having 131 in. annually. Cornwall is the long promontory which gradually narrows toward Land's End, the extreme southwest tip of Britain. Patches of granite here rise to 1,368 ft.

Rivers and Lakes. Some English rivers are too small for their estuaries; the estuary fills the drowned lower portion of the valley, and permits the tidal effect to reach considerable distances upstream, where deep-sea craft may go. The most important rivers are the Thames, about 210 mi. long, and an area of basin almost 6,000 sq. mi. The Severn is of about the same length and has a similar basin area. The Trent, Ouse, Wye, Tyne, Mersey, Ribble and Humber are also of commercial importance. The whole of the country is well watered. The abundance of streams is the result of a combination of impervious rock and heavy rainfall. There are two groups of lakes: that of Cumberland, Westmoreland and north Lancashire, and that of the broads of Norfolk and Suffolk. Windermere, 10½ mi. long, is the largest lake.

Climate. Because of its position on the leeward side of the Atlantic, England, although in about the same latitude as Labrador, has a remarkably mild

climate. The contrast between winter and summer conditions as influenced by the ocean is most remarkable. Thus, the July isotherms run in a general east-west direction, the temperature decreasing with latitude. In winter, however, the influence of the North Atlantic Drift is much stronger, the warm waters being pushed far to the northeast between Iceland and Norway. As a consequence January land temperatures decrease eastward rather than northward, that is, it is a question of distance from the Atlantic rather than from the Equator. Thus the January average for the northernmost part of Scotland, 40° F., is the same as for Southampton, in the south of England. Because of this beneficial influence of the surrounding waters, the average January temperature about Britain is approximately 30° higher than is normal for that latitude, although the summers are about the average. January in London is warmer than Nashville, Tenn., 1,100 mi. farther south. Thus the winters may be classed as mild and the summers cool. Rainfall is everywhere sufficient for crops, and decreases from west to east. Since the higher elevations of Great Britain are mostly in the west, the rainfall of the east is dependent upon the cyclonic storms in whose paths the country lies. London receives only 25 in. of rain annually, but, since a fair share of it comes during the growing season and the cool summers result in little evaporation, the supply is ample for ordinary crops. The sunshine, as in most of northwestern Europe, is deficient, averaging 4 hours daily and diminishing from 38% of the possible amount in the southeast to 27% in the northwest. In general the climate is well suited for both agriculture and human activities.

Flora and Fauna. The English flora corresponds in a general way to that of the continent of Europe. In the days when the Fens in eastern England were uninclosed their streams were famous for their wealth of fresh water fish: pike, eels, perch, bream, tench, dace and roach. Eels were present in enormous quantities, and it was no uncommon thing for rents to be assessed at so many thousands of eels. The multitude of fish was equalled by the multitude of wild fowl, but the effective draining of the Fens has banished almost the whole of these creatures, finned as well as winged, with the exception of some wild duck, widgeon and teal. The wild fauna of England is scarce, mainly on account of the density of human population. Deer and fox have been preserved by the huntsmen. Rabbits are so numerous in some districts that they are considered pests. Salmon and trout are plentiful in many streams, and char in the lakes of Cumberland and Westmoreland.

Particularly individual to England are the thrushes, larks, cuckoos and nightingales found in the countryside. In the literature and song of the nation these birds have been celebrated for centuries.

Mining Industry. The deposits of coal in England are not only enormous in extent but also excellent in quality. Since the World War Britain has supplanted Germany in first place in reserves, pos-

sessing about a third of the total of all Europe. So vast are the beds that at the present rate of consumption it is estimated that they will last for many centuries. The varieties available are all of high grade and include anthracite, steam, gas and coking coals. Individual beds are known with a maximum thickness of 30 ft. and in one section there are 36 separate seams totaling 144 ft. of coal. The beds occur at all angles from horizontal to vertical. The deposits are admirably distributed both for domestic use and export. Some of them are close to iron ore, others are practically on tidewater. One of the great advantages of the English coal industry is the relatively short land haul either to local markets or to the seaboard. The average distance for all English coal from mine to port is estimated at 25 mi. costing about 47 cents, as compared with 310 mi. from the mines of West Virginia to Hampton Roads, costing about \$1.25. The combined area of the coal fields of the British Isles totals about 6,600 sq. mi., or one-tenth that of the Appalachian field of the United States. Of the total reserves of Britain, estimated at about 190,000,000,000 tons, the fields of England account for about 61%, Scotland, 12%, and Wales 21%. The important coal fields occur about the Pennines, which originally were covered by coal formations that have been eroded from all except the lower flanks. On the east are the Durham-Northumberland and the York-Derby-Nottingham fields; on the west are the Cumberland-Lancashire fields. To the south of the Pennines is a group of small deposits comprising the Midlands district. The Durham-Northumberland field possesses several advantages. It has much excellent coking coal, it lies close to tidewater and also to iron ore deposits. As a result it is both a large exporter and a great industrial district, specializing in iron and steel goods, particularly shipbuilding. Newcastle-on-Tyne is one of its leading shipbuilding centers as well as an important coal exporter supplying much fuel to London and Baltic Europe. To the south lies the York-Derby-Nottingham coal field—the most important producer of all England. Its output is largely used locally in iron, steel and textiles. The Cumberland field is small and principally of interest because of its association with the local iron ores and the iron and steel industry of Barrow. South of it lies the Lancashire district where coal is the major support of the world's greatest cotton-textile region. The potteries form a southward extension—pottery clay being found in some of the coal mines, although dependence is now mainly on Cornwell clays. South of the Pennines the coal is used in the Birmingham district, the Black Country, where metal industries again predominate.

Of all English manufactures that of iron and steel is most fundamental. In a country so highly industrialized and so dependent upon foreign commerce these basic materials are essential. Out of them are made the machines used for manufacture as well as the carriers of her commerce on land and sea. Of the natural resources essential for industrial growth,

only coal ranks ahead of iron ore, and of this former, England has abundant supplies. Her position in iron ore resources, however, is far less satisfactory. In her vast reserve she possesses only a very limited amount of high-grade ore, but possibly twice as much which, although low in iron content, is so close to coal and to tidewater as to make its working practicable. Huge deposits, a billion tons or more, are so poor as to be a doubtful asset. Thus iron-ore resources which were ample for her needs at the time of the industrial revolution are now quite inadequate. Even as late as 1875 her mines accounted for one-half of the world's output of ore but in 1910 this was slightly more than one-tenth. To-day England is dependent upon imported ore for the production of half of her pig iron. For the past 50 years or more her per capita production of this staple has remained practically unchanged; that of her industrial rivals has multiplied at a high rate; that of the United States, increasing by one-half every decade, surpassed that of England in 1888. The leading iron and steel district is that of Cleveland. Close to the Durham field with its excellent coking coals, to tidewater at Middlesbrough, and yielding the largest output of domestic ore, this district accounts for one-third of the country's pig-iron production. Its equipment is the best in Britain, and while the local ore output shows a constantly declining grade, with greater difficulty in mining, the import of ores from abroad is easy. The Sheffield district is one of the older steel centers. It has specialized in lighter steel products, cutlery and hardware for which it has a world-wide reputation.

Of the other minerals, there is a little tin, copper, lead and zinc still produced, but the deposits have been almost worked out and the output is declining. Of the non-metal group there are important industries based upon the local deposits of limestone, china clay, chalk and quarry rock.

Forests. Originally covered with deciduous forest Britain now ranks among the lowest of any European country in the proportion of area under tree cover. Several centuries ago the rich oak forests of the island contributed to England's being the paramount sea power of the world, for from these solid old trees were built the many ships which put forth for foreign waters. Clearing for pasture and for cultivation, for charcoal and household fuel, as well as for construction timber, has gone on until now in England only 1 acre in 25 is forested. Many of the so-called forests are really to-day practically without tree cover. In spite of the dense population England has undertaken to replant at the rate of 20,000 acres per year. Most of the country's wood requirements must be met by imports, chiefly from the Baltic countries and Canada. In addition to miscellaneous uses, the mining industry requires a huge quantity of pit props and the printing industry requires a large import of pulp and paper. The great forest which once covered a large area between the North and South Downs and the Hampshire uplands was of oak. On the heavier soils of the country and on some sandy soils the oak has remained

dominant. Beech is found on the lighter soils of the chalk plateau. Ash and birch respectively enter into the succession of vegetation to beechwood on chalk and to oakwood on sandy soils. Yew is especially associated with chalk scrub, and alder and willow are the dominant trees on very wet soils.

Agriculture. Up to 1875 farming in England was prosperous, but during the past half century it has shown a marked decline. From the peak of agricultural activity in the seventies up to 1914, the arable land of England decreased by almost one-fourth. Even the World War with its threatened food shortage was able to stem the tide only temporarily. Less than 7% of the population are engaged in farming, about the same number as are employed in mining or in a single branch of industry—that of textiles. No other of the great nations is so highly industrialized, no other has allowed its agricultural output to become so small, resulting in so great a dependence upon the rest of the world for foodstuffs. Under normal conditions, England produces sufficient food to support her for only 6 weeks. The physical conditions affecting English agriculture help to explain some of these trends. Thus the marine climate is in general much better suited to pastoral than to cereal production; persistent rains in some parts frequently delay seeding and interfere with the harvest; there is much hilly and mountainous land unsuited for cultivation and even the chalk downs of the lowlands, while productive of short sweet grass, are poorly adapted to cultivated crops. While it is true that these conditions have been of long standing, their influence could be ignored only under the relatively non-competitive conditions preceding 1875. Beginning about that time, however, western Europe began to be flooded with machine raised wheat from the cheap virgin lands of the New World. The British government maintained a free trade policy to insure cheap food for its industrial workers, and English ploughlands were turned into sheepwalks. As the competition of overseas foodstuffs was naturally least in the perishable materials, the British farmer turned more to the production of fresh meat, vegetables, fruits and dairy products. With the advent of refrigerated meats, he has emphasized more and more the raising of blooded stock and the production of fresh milk. Quality of product rather than cheapness has enabled him to retain a part of the domestic market.

Of the crops, oats, hay, wheat and barley are, in the order given, the most important according to acreage occupied. Sheep are about six times as numerous as swine and over three times as numerous as cattle. England holds in wool production high rank among European countries.

Fisheries. Not only is the per capita consumption, about 65 pounds, very high, but fish also constitute the only domestic food product of which England has a large exportable surplus. A fishing industry of such proportions is of manifest importance to a country otherwise so deficient in foodstuffs, as well as serving as a training school for British seamen.

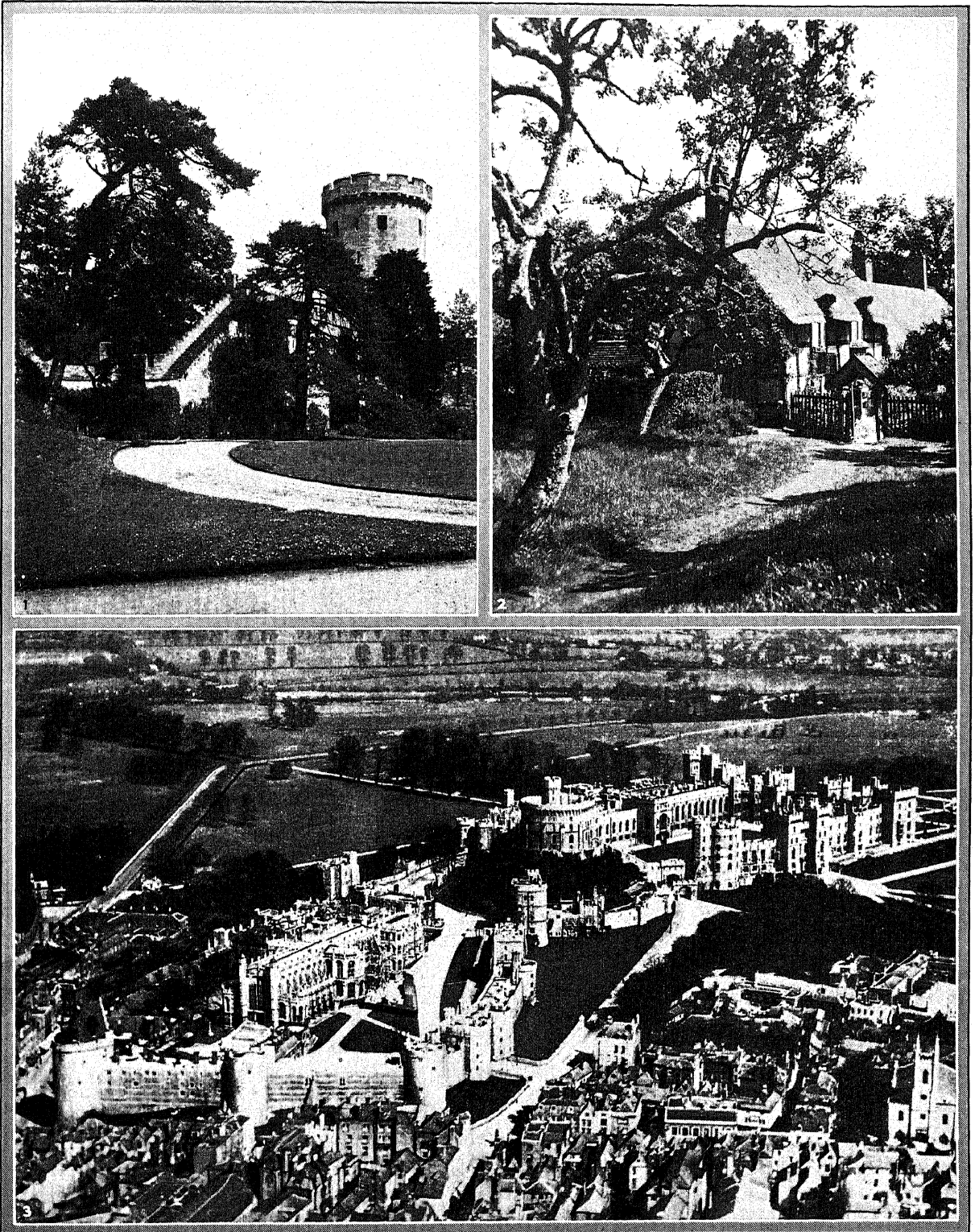
The most productive areas are the North Sea and Iceland waters. The Dogger Bank, the most famous of the world's fisheries, is a submarine plateau of about 7,000 sq. mi. submerged to a depth of about 120 ft. Located only some 60 mi. east of Yorkshire, it is the chief factor in making all the east coast ports of Britain important fishing centers, the operating bases for the fleets with exceptional facilities for handling and marketing the catch. Each day at dawn, the world's most famous fish market—Billingsgate in London—is selling approximately 1,500,000 lbs. of fish caught only a few hours before and rushed thither by special boats and trains. With the increasing drain upon the North Sea fisheries, the catch has been decreasing and the fishermen are going farther afield, the larger yield more than compensating for the greater distance. The fish include cod, herring, sole, haddock, turbot, mackerel and plaice.

Manufactures. While second in importance to metals in the country's industries, textiles have long been the leading item in England's foreign trade, cotton and wool manufactures accounting for almost one-third of the value of all exports—with raw cotton the country's largest single import and cotton goods the chief item in textile manufacture. England possesses about a third of the world's cotton spindles, which is more than all the rest of Europe, although the consumption of raw cotton is much less and the value of the output somewhat smaller than that of the United States. But since English goods are finer on the average, they use less cotton per spindle than American mills with coarser products. Notwithstanding growing foreign competition, Lancashire still maintains its position as the world's greatest cotton-textile district. The facilities and organizations which have grown up in Liverpool and Manchester for handling the raw cotton and marketing the manufactured products tend to make removal of the industry very difficult.

Sheep raising and the spinning and weaving of wool are ancient industries in England. The climatic, topographic and economic conditions by which wool growing early assumed significant proportions made of England, even in the Middle Ages, a great exporter of that commodity. Wool from the Pennine districts was exported especially to Flanders for cloth making and even English cloth was sent there to be dyed and finished. With the subsequent immigration of Flemish weavers to eastern Britain, the manufacture of woollens flourished. The gradual change to power-driven machinery served to concentrate the wool working in the Yorkshire coal field. The importance of this district for wool is mainly due to the early settlement of the immigrant weavers, the large amount of wool from the Pennines, and, later, to the local coal supplies. There is some overlap of the woollen and cotton areas, but in general the superior adaptability of the Lancashire region for cotton has served to give that fiber almost a monopoly there, while two-thirds of the wool spindles and 70% of the looms are in Yorkshire with Bradford and Leeds as the chief centers.

Silk manufacture has never been important in Eng-

ENGLAND



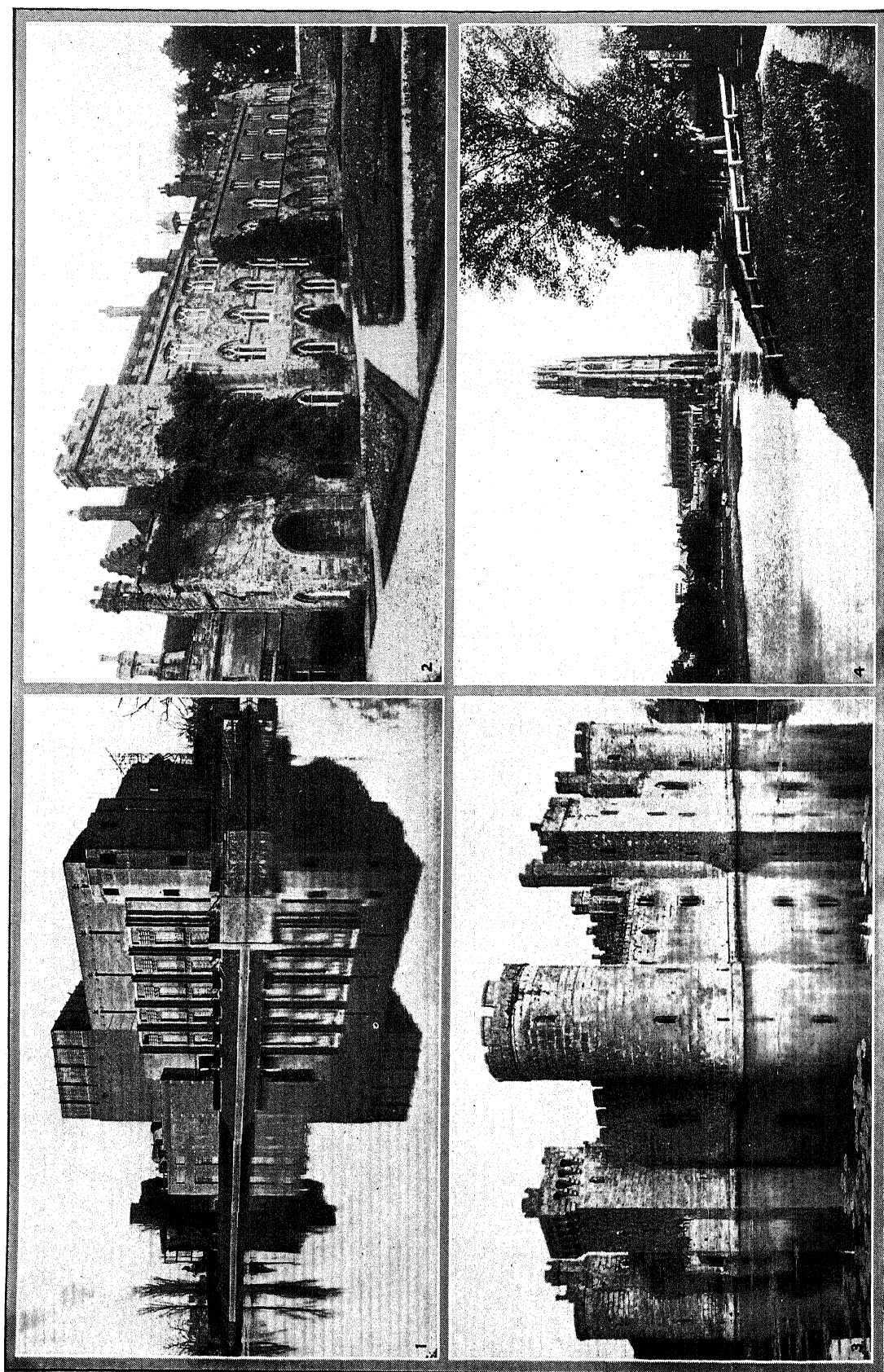
1. COURTESY LONDON MIDLAND AND SCOTTISH CORP.; 2. GREAT WESTERN RAILWAY OF ENGLAND; 3. BY AEROFILMS, FROM EWING GALLOWAY

CASTLES AND COTTAGES OF THE ENGLISH COUNTRYSIDE

1. Guy's Tower of Warwick Castle, Warwickshire. 2. Ann Hathaway's cottage at Shottery, near Stratford, in Warwickshire. 3. Air view of Windsor Castle and the surrounding

country, on the Thames in Berkshire. Since the times of Edward III, Windsor has been the summer residence of the English royal family.

ENGLAND



1. ACME PHOTO; 2. COURTESY GREAT WESTERN RAILWAY OF ENGLAND; 3. 4. TRAVEL ASSOCIATION OF GREAT BRITAIN & IRELAND

HISTORIC SCENES IN ENGLAND

1. The New Shakespeare Memorial Theatre in Stratford-on-Avon.
2. Battle Abbey in Sussex, founded by William the Conqueror.
3. Bodiam Castle in Essex, built in the days following the Norman Conquest.
4. St. Botolph's Church in Boston, Lincolnshire, scene of the early activities of the Pilgrim Fathers.

ENGLAND AND WALES

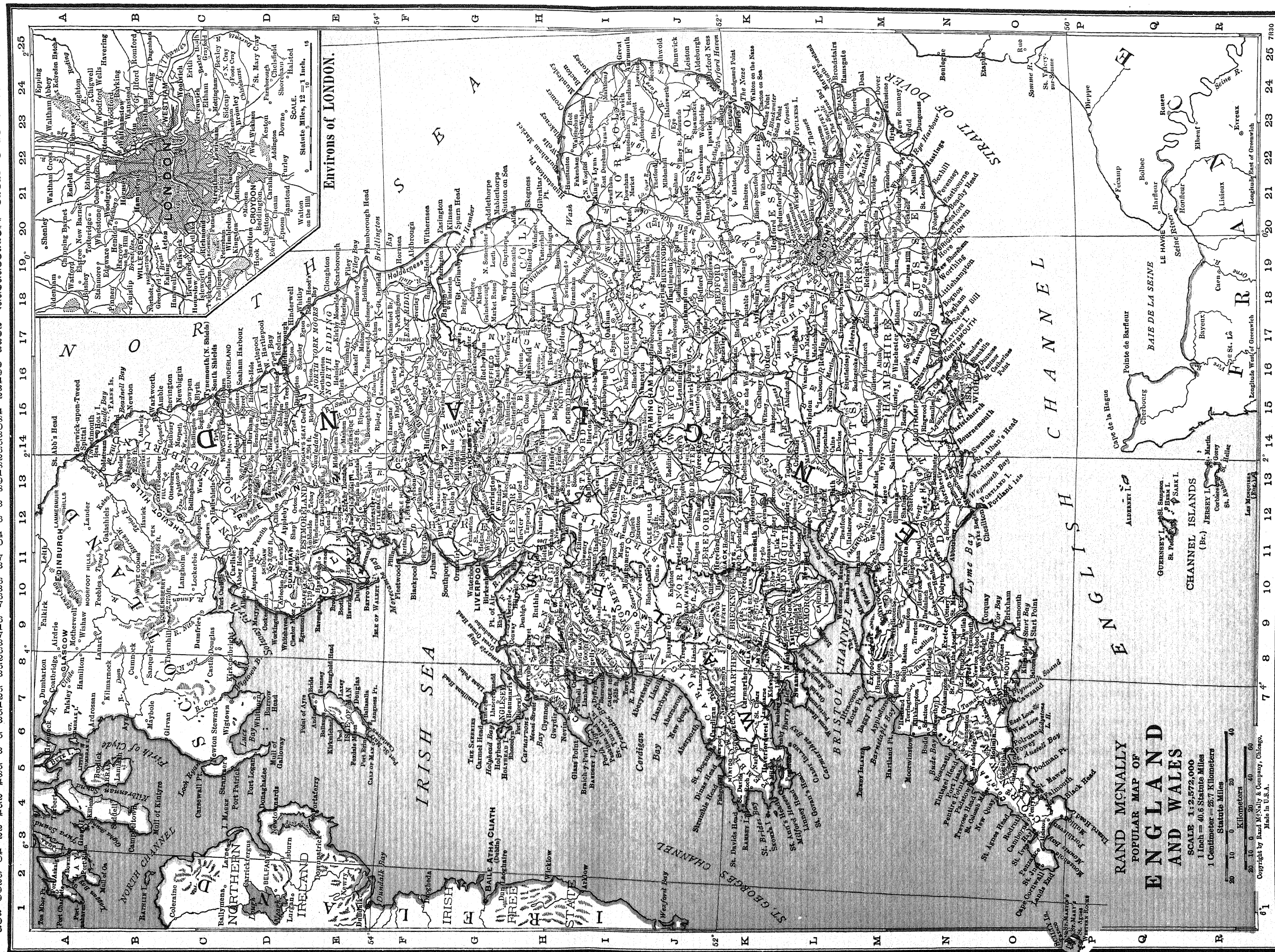
Area, 58,340 sq. m.
Pop. . . . 39,947,931

PRINCIPAL CITIES

(Including Figures from Latest Population Estimates)

Pop.—Thousands

- 73 Barrow-in-Furness E 10
- 69 Bath L 12
- 148 Birkenhead G 10
- 1002 Birmingham G 14
- 125 Blackburn F 12
- 102 Blackpool F 10
- 177 Bolton G 12
- 85 Bootle E 9
- 117 Bournemouth G 10
- 208 Bradford F 14
- 147 Brighton N 20
- 397 Bristol N 13
- 98 Burnley L 13
- 67 Cambridge J 20
- 224 Cardiff L 10
- 61 Chesterfield G 15
- 167 Coventry J 15
- 233 Croydon L 19
- 72 Darlington D 15
- 142 Derby H 15
- 82 Devonport O 7
- 68 Enfield L 19
- 66 Exeter N 9
- 61 Gillingham M 13
- 53 Gloucester K 13
- 92 Great Grimsby G 19
- 101 Greenwich L 19
- 98 Halifax F 14
- 62 Hanley H 13
- 65 Hastings N 22
- 113 Huddersfield F 14
- 313 Hull F 18
- 131 Ilford L 20
- 83 Ipswich J 23
- 483 Leeds F 15
- 239 Leicester I 16
- 129 Leyton B 22
- 66 Lincoln H 18
- 856 Liverpool G 11
- 4397 London K 19
- 69 Luton K 18
- 766 Manchester G 13
- 138 Middlesbrough D 16
- 283 Newcastle-on-Tyne C 14
- 89 Newport L 10
- 92 Northampton J 17
- 126 Norwich I 23
- 269 Nottingham H 16
- 140 Oldham G 13
- 81 Oxford K 16
- 208 Plymouth O 7
- 249 Portsmouth N 16
- 119 Preston F 11
- 97 Reading L 17
- 90 Rochdale G 13
- 70 Rotherham G 16
- 107 St. Helens G 12
- 512 Sheffield G 15
- 84 Smethwick J 13
- 176 Southampton N 15
- 120 Southend L 22
- 79 Southport G 11
- 118 S. Shields C 15
- 126 Stockport G 13
- 68 Stockton-on-Tees D 15
- 277 Stoke-on-Trent H 13
- 186 Sunderland C 15
- 165 Swansea L 8
- 62 Swindon L 14
- 158 Tottenham L 19
- 65 Tynemouth C 15
- 103 Walsall I 14
- 133 Walthamstow L 20
- 79 Warrington G 12
- 81 W. Bromwich I 14
- 294 Westham L 20
- 68 W. Hartlepool G 16
- 85 Wigan G 12
- 184 Willesden L 19
- 59 Wimbledon L 19
- 133 Wolverhampton I 13
- 147 Woolwich L 20
- 85 York F 16



RAND McNALLY
POPULAR MAP OF
ENGLAND
AND WALES

SCALE 1:2,572,000
1 inch = 40.6 Statute Miles
1 Centimeter = 25.7 Kilometers
Statute Miles
Kilometers

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land, but in the making of its substitute, rayon, a product of the chemical laboratory, so well adapted to that highly industrialized country, England in 1930 shared with Italy second rank among European producers of this material. Favored by a large home market and a protective tariff, the industry has had a rapid growth. In addition to the metal and textile industries there is a great variety of manufacturing; among which may be mentioned the printing, chemical, lumber, leather and rubber groups.

Communications. Since no part of England is far from deep water the importance of inland transportation is proportionately reduced. There is an excellent and comprehensive network of railways which has been supplemented by a rather extensive system of canals. These latter consist mainly of short links of varying dimensions, constructed chiefly to facilitate the movement of coal and iron. Since the coming of the railways in the second quarter of the 19th century no new inland waterways have been constructed except that between Manchester and Liverpool, which is really an ocean ship canal. The Thames estuary faces two of the world's busiest rivers, the Rhine and the Scheldt, which afford outlet to the most active part of the continent. The tides of the Thames estuary have an exceptionally high range, the maximum being about 20 ft. While this movement helps to keep the river clear of silt, it necessitates building berths for the vessels that are enclosed by locks so that the water level may be maintained constant. The very largest vessels must anchor at Tilbury, a sort of down-river port, and since they must unload too, there has been a growing tendency for the large liners to stop at Southampton and forward their passengers and mails to London, 78 miles, by rail from there. The double entrance on either side of the Isle of Wight gives Southampton a double tide, of particular value in these days of large ships. The chief seaports are London, Liverpool, Southampton, Hull, Bristol, Manchester, and Newcastle-on-Tyne. There is a splendid air service between the principal cities of the British Isles, and from the London airport at Croydon to many of the chief cities of Europe. In 1930 the British merchant marine totaled 8,238 vessels of 20,428,444 tons.

Commerce and Finance. Of imports, foodstuffs, semi-manufactured goods, and raw materials, of which raw cotton is most important, make up a little less than three-fourths of the total value; for exports a somewhat larger proportion consists of manufactures, though coal constitutes by far the greatest tonnage. Britain dominates the seaborne coal trade as Germany does that overland, and in 1913 at the peak of the coal industry, almost 100,000,000 tons were shipped, 76,600,000 tons in 1929. In 1929 the United States held first place in supplying goods to Britain, 16% of the total imports. Argentina ranked second, over 6%. British India was England's best customer. Imports from the United States in 1929 amounted to \$847,979,856, and exports to the United States \$329,766,638.

The monetary unit is the pound sterling, normally

\$4.86¼. The British revenue of 1930 amounted to £814,970,280, and the expenditure £829,493,543.

Defense. The land forces consist of the regular army, the territorial army and the reserve forces. The regular army serves both at home and in the dominions overseas. The strength of the British navy in 1930 was 20 battleships and battle cruisers, 54 light cruisers, 150 flotilla leaders and destroyers, 53 submarines and 7 aircraft carriers. In 1931 the Royal Air Force consisted of 73 squadrons of 12 airplanes each.

Religion. The established church in England is the Episcopal, of which the sovereign is the supreme head. The church is governed by two archbishops and 31 bishops. The Archbishop of Canterbury is styled the primate of all England and to him belongs the privilege of crowning the kings and queens of England. The Archbishop of York is styled primate of England. The doctrines of the Church of England are contained in the Book of Common Prayer. The organizations of the various nonconformist churches are highly developed. The Roman Catholic Church has three archbishops, of whom one is a cardinal, 13 bishops and four bishops-auxiliary. There are about 300,000 adherents of the Jewish religion, with about 200 synagogues.

Government. The British House of Commons, —the mother of parliaments—is the pattern on which the legislative chambers of all democratic countries are based. The executive power vested in the Crown can practically only be exercised by the Cabinet, a committee of about a score of Ministers, who are responsible to Parliament and must resign when they lose the confidence of that body. Since the Parliament Act of 1911 turned the House of Lords into a mere delaying and revising body, the ultimate sovereign power resides in the House of Commons, which derives its authority from the fact that it represents, and is freely elected by, the whole body of enfranchised citizens. But there are limits to the sovereignty of Parliament: it can do nothing important to which public opinion is definitely opposed. For purposes of local government England is divided into administrative counties, and these into parishes. Parishes are variously combined into districts, unions and other groups. The larger towns are incorporated as boroughs or cities. Thus are formed areas, to each of which a certain measure of self-government is entrusted. Within such areas a council is elected, with various powers. The supreme judicial authority is the House of Lords, which is the ultimate court of appeal from all courts in the United Kingdom.

Population. England has a population density of over one to the acre, a figure exceeded by no other country, and has in fact more people than all of the self-governing dominions of the Empire together. The manufacturing district of the north accounts for half of the total industrial and urban population; one-fourth is in or near London, and the remaining one-fourth scattered. Such areas as London under the impetus of unsurpassed commercial and political ad-

vantages have continued to grow, but with these exceptions a great shifting from farm and pasture to the coal areas has been revolutionary. Besides London, the capital, the principal cities are Birmingham, Liverpool, Manchester, Leeds, Sheffield and Bristol. In 1931 there were 43 cities with more than 100,000 inhabitants. Pop. 1921, 35,779,833; 1931, 37,903,687.

ENGLAND, HISTORY OF. How long England has been inhabited by man it is impossible to say. Perhaps 50,000 years is as good a guess as any in the present state of our knowledge. The earliest men who have left traces of their occupation lived in the open or in caves, sustained themselves by hunting and fishing, and made their tools and weapons of chipped flint. Within a few thousand years of 5000 B.C. men resident in England made a tremendous stride in civilization by learning to domesticate animals, to make weapons of polished stone and to manufacture pottery. The men of this age built crude huts and lived in communities. Somewhere around 2000 B.C. human labor was rendered far more efficient by the invention of bronze tools. Men of the bronze age practiced agriculture, wove cloth, mined tin and copper and developed a trade with the continent. The substitution of iron for bronze, which was made probably between 600 and 400 B.C., produced a still higher stage of culture and much more comfortable conditions of existence. In this period the island was occupied by a people who spoke Celtic, were organized politically in tribes and clans, were divided into social classes, and practiced a polytheistic religion.

Roman Occupation. Upon this primitive, pastoral civilization was suddenly imposed the highly developed municipal culture of Rome. Though JULIUS CAESAR established Roman contact with Britain by his expeditions there in 55 and 54 B.C., the Roman conquest did not begin until 43 A.D. (*see* BRITAIN). The Romans conquered and held the island as far north as the wall which they built between Tyne and Solway. South of the wall, the hills of the north and west were occupied only by military garrisons. Only in the plain was the whole fabric of Roman civilization established. There towns were built, well-constructed roads took the place of the rough trails of the Celts, and some sections of the country were covered with Roman estates. Industry and commerce flourished. Many of the native Celts adopted the material comforts of Rome, spoke Latin and became Christian. Yet the Romanization of the Celts does not appear to have been thorough. After the Roman Government was forced by the barbarian invasions to abandon the province early in the 5th century, traces of the Roman occupation other than material remains nearly disappeared. Roman culture probably did not survive sufficiently to have had any significant influence in producing the English civilization of to-day.

Anglo-Saxon Period, 5th Century-1066. Even while the Roman Government still controlled Britain, German peoples had begun to make piratical attacks upon the coasts. In the first half of the 5th century

these raids developed into an invasion for conquest and settlement. The warfare lasted intermittently until the 7th century. The Germans then occupied the plain, having driven the Celts into the hills of the north and west. In the plain, where the Celts appear to have survived in large numbers only in the west, German institutions supplanted the previously existing civilization.

The conquerors were an agricultural people who lived in small villages and allowed the towns and the commerce of the Romans to fall into decay. They possessed no written literature, and they were pagans. Socially the primary unit appears to have been the freeman. There were also a nobility of birth, slaves who were chattels, and an intermediate group of men who were dependent upon masters but legally protected in their persons. Politically the Anglo-Saxons were divided into groups which, by the end of the conquest, were ruled each by a king. They possessed courts; but an individual still had the right of exacting private vengeance for an injury, if the court failed to provide redress for his wrong. Every freeman was a warrior, and the army was the tribe in arms.

Three peoples took part in the conquest, the Angles, Saxons and Jutes. By the first part of the 7th century they had established seven important kingdoms. The Angles occupied Northumbria, Mercia and East Anglia; the Saxons lived in Essex, Wessex and Sussex, and the Jutes were confined mainly to Kent. The consolidation of these kingdoms into a united England took several centuries. Three principal factors produced the unification. Wars enabled the stronger kingdoms to absorb the weaker ones; a common ecclesiastical organization provided an example of unity, and the pressure of the Danes, a common enemy, finished the process.

Usually one king succeeded in holding tributary some kingdoms other than his own and thus was more influential than the other kings. At the close of the conquest the King of Kent held this position. After 616 it passed to the kings of Northumbria. During the 8th century the kings of Mercia were the most powerful. Early in the 9th century the King of Wessex acquired the leadership just in time to throw upon his kingdom the brunt of the defense against the Danes.

Christianity was first brought to Kent in 597 by St. Augustine, who was sent from Rome as a missionary by the Pope. From Kent the new religion spread to other kingdoms. A few years later Christianity was brought to northern England by Celtic missionaries who represented the Church, which had survived among the Celts from Roman times. For a time England bade fair to be split between two Christian churches with different forms of organization and observance. In 664, however, the King of Northumbria decided to follow the form brought from Rome by St. Augustine. Within a short period ecclesiastical unity resulted.

The Danes began to invade Britain near the close

of the 8th century. They came from the Scandinavian lands, were of the same Nordic racial stock as the Anglo-Saxons, and possessed a cruder civilization of the same type as that of the Anglo-Saxons. After many years of piratical attacks, they began to conquer the country for settlement. Having overrun the northeastern kingdoms, they invaded Wessex in 871. In the same year ALFRED THE GREAT, the most famous of the Anglo-Saxon kings, came to the throne. By several campaigns he forced the Danes to withdraw to the northeastern part of England, where they settled permanently. Alfred's son and his grandsons gradually conquered this district, known as the DANELAW. Near the middle of the 10th century all England was finally united under the rule of one king.

After a long interval of peace, new armies of Danes conquered the country. In 1017 they placed their king, CANUTE, upon the English throne. Under his rule England seemed on the way to become part of a great Scandinavian empire of the north. After Canute's death, however, his lands were divided. In 1042 the death of the second of his sons to rule England made it possible to restore the royal line of Wessex in the person of EDWARD THE CONFESSOR. The Danish invasions brought to England a large new element in the population, and they had pronounced social and economic effects. The Danes, however, contributed few new institutions to English civilization.

Throughout the Anglo-Saxon period agriculture remained the mainstay of existence. The Christian missionaries stimulated intercourse with the continent, and the Danes, who were enterprising traders, brought about an increase of commerce sufficient to cause the growth of several urban units or towns. Socially the period saw a decline in the status of the freemen. Warfare, famines and economic developments forced many freemen to become serfs, economically and legally dependent upon the aristocratic, land-owning class of warriors, which the numerous wars had produced. The slaves, on the other hand, nearly disappeared. The country was governed after its unification by the king in association with an assembly composed of the higher officials in State and Church and the leading nobles. The king was represented by officials in the counties and their subdivisions, the hundreds; but most of the work of Government was performed in these districts by popular assemblies. With the coming of the clergy, schools were established, and Anglo-Saxon soon became a written language with a literature of its own.

The Norman Period, 1066-1154. In 1066 the Normans led by William the Conqueror (*see* WILLIAM I) won the BATTLE OF HASTINGS. Within a few years they made themselves masters of England. Their influence upon England was deep and lasting. They did not come in large numbers, but they came as a ruling caste. Though mainly Scandinavian in origin, they brought with them a French culture which fused with the Anglo-Saxon civilization to produce many new institutions.

Among these was FEUDALISM. William confiscated nearly all the land of England and bestowed it mainly upon his Norman followers to be held by feudal tenure. The recipients owed to the King military and judicial service and payments of money on various occasions. The tenants or vassals of the King leased parts of the lands they received on similar terms, thus becoming the lords of vassals. Because the lord in the feudal organization enjoyed extensive political, military and judicial rights over his vassals, feudalism tended to become a disintegrating political force. William and his sons, WILLIAM II and HENRY I, were such strong and able rulers that they held the feudal barons in check, though they had to meet several baronial rebellions. Under the weak STEPHEN, when feudalism had free play, disorder and anarchy became rife. The next King restored order; but for centuries the power of the barons remained a potent obstacle both to royal tyranny and to royal efficiency.

Though no extensive fundamental changes were made in the Government, it was administered in a way that rendered it far more powerful. The central Government became more efficient, and the King's local officials were made more dependent. The new department of the exchequer systematized the royal finances. Royal justices began to hold courts on local circuits, bringing to the King's subjects the better justice of the King's courts. The Norman kings, aside from Stephen, gave their subjects good government.

The Church was thoroughly reformed. Norman prelates, whom William appointed to places in the English Church, soon eliminated the laxness of discipline prevalent among the Anglo-Saxon clergy, and infused the Church with new spiritual and intellectual vigor. The government of the Church was also reorganized. The clergy were given their own councils and courts. They were rendered so independent of the King that conflicts between Church and State ensued. Henry I was forced to settle by compromise a long quarrel with ANSELM, Archbishop of Canterbury, who chose to obey the command of the Pope rather than that of the King, when the two conflicted.

The Norman conquest quickened the intercourse between England and the continent. Trade increased. The continental intellectual influence resulted in the establishment of many new schools and a vast development of learning. The French brought by the conquerors long remained the speech of the upper classes. English ultimately prevailed, but it was profoundly changed by a large infusion of French words.

The Early Angevins, 1154-1216. HENRY II possessed a genius for government. As soon as he had ended the anarchy left by his predecessor, he began a series of administrative and judicial reforms. Though he may have been actuated largely by the desire to increase the royal authority, the result of his changes was to give to the mass of his subjects greater liberties and better protection against oppression and wrong. By making available to all royal writs which brought certain classes of cases into the royal courts, and by the extension and systematization

of the itinerant justices, Henry rendered it easier for the weak to obtain justice from the strong. He established as part of the normal procedure in the royal courts the practices which developed into the later grand and petit juries. These and other alterations in the organization and procedure of the royal courts centralized the Government, encroached far upon the powers of the barons, and laid the solid foundation of the English judicial system.

His attempt to curb the power of the clergy was less successful. Because the ecclesiastical courts which claimed jurisdiction over clergymen could not inflict adequate penalties for crimes, Henry sought to have criminal clergymen punished by royal courts. THOMAS À BECKET, the Archbishop of Canterbury, opposed this attack on clerical privilege. After six years of controversy Becket's murder by irresponsible followers of the King caused Becket to be acclaimed a martyr. Henry was forced to forego some of the control over the clergy that he had sought to establish.

The increase of the royal authority under Henry II roused the opposition of the barons. The middle class liked his good government, but objected to the cost of it. Under RICHARD I, who spent most of the 10 years of his reign on the Third Crusade (*see CRUSADES*) or waging war in France, the weight of taxation increased. JOHN wielded the authority established by his father arbitrarily and capriciously. In 1215 the barons, supported by the clergy and many of the middle class, revolted and forced John to sign the Great Charter. (*See MAGNA CARTA.*) By this document the barons sought to eliminate the abuses in the Government and to restore between the King and the barons the balance of power that had been lacking since the reign of Henry II. Among other things it stated virtually the principle that freemen might not be deprived of life, liberty or property without due process of law, thus placing the King below the law. For centuries after 1215 the English people turned to the Great Charter whenever they wished to assert their liberties against the king.

Henry, Richard and John in succession had to meet the hostility of the kings of France. Henry, by inheritance and marriage, controlled provinces in western France that represented more than half of the French kingdom. The power of the French King was so menaced thereby that he attempted to seize portions of the Angevin holdings whenever opportunity offered. Henry and Richard held their own. John lost the northern half, retaining possession only of Aquitaine.

The Later Angevins, 1216-1399. In the 13th century was laid the foundation upon which was built the institution we know as Parliament. Despite the Great Charter, the barons continued to be dissatisfied with the Government. HENRY III, after the disorder of a long minority, ruled weakly. The barons, seeking reforms, revolted and practically assumed control of the Government. Because they swung the pendulum too far, Henry was able eventually to defeat them and recover his authority.

Meanwhile tentative steps had been taken toward the introduction of a representative element into the central Government. Since the Norman conquest the kings had been meeting frequently with the Great Council, which took the place of the Anglo-Saxon royal assembly. It was composed of the King's immediate vassals and of some of his officials. Once in John's reign and several times in Henry's, representatives of the rural middle class were summoned to meet with the council to assist the king in the transaction of his business. At least once representatives of the urban population were also summoned.

Edward I, who was an able statesman, improved the organization and procedure of the courts, increased the efficiency of the administrative departments, and legislated extensively for the benefit of various classes of society. As part of his program of betterment, he continued and extended the practice of calling representatives of the middle class to sit in central royal assemblies. By the close of his reign the usage was firmly established. The representatives had little power. The King could summon and consult them or not, as he chose. In 1297, however, a clause was added to the confirmation of the Great Charter, wrested from the King by the barons, whereby he seems to have promised that he would not henceforth levy non-feudal taxes without the consent of a representative assembly. Since the King was by then largely dependent upon this kind of taxation, the promise placed the representatives in a position, which they utilized in later reigns, to secure some voice in the affairs of the nation.

Edward I entertained the vision of a united Britain. He conquered the portion of Wales that was still independent. His attempt to subdue Scotland not only failed; it served also to promote an enmity between the two kingdoms which outlasted the Middle Ages.

England in the 13th century was still predominantly rural. The economic unit of rural organization was the MANOR. It was an estate controlled by a lord. On the manor were tenants who lived in a village group. Some of the tenants were free. The majority usually consisted of villeins who were bound to the soil. They owed the lord services in labor as well as rents and fees. Over all his tenants the lord had some rights of jurisdiction. The arable lands of the manor were customarily divided into two or three great fields. Each field lay fallow once every two or three years. The cultivated holdings of the lord and his tenants consisted of intermixed acre strips in these great fields. Wood and pasture were used in common.

The growth of commerce after the Norman conquest caused towns to increase in number and in size. (*See COMMUNE.*) By the 13th century many towns possessed royal charters giving them extensive rights of self-government. In each town the merchants usually organized a GILD. The merchant gild promoted social and charitable objects and strove to maintain a monopoly of the trade of the town for its

members. It also gave the aid and protection not yet provided by the central Government to its members who traded outside the town. Craft guilds were beginning to be formed. Each was associated with a particular industry and attempted to regulate locally the manufacture as well as the sale of the product. The townsmen constituted an element of growing importance in the community.

EDWARD II was incompetent. The barons, seeking to recover the influence in the Government which they had lost under Edward I, limited the royal prerogative extensively during a large part of the reign. His rule remained so poor that in 1327 the barons by revolt secured his deposition.

His son, Edward III, was interested chiefly in warfare. In 1337 he began the HUNDRED YEARS' WAR with France. The English possession of Aquitaine was a source of much friction. The French King had helped the Scots when Edward was at war with them. And there were many difficulties about commerce, particularly about the English staple trade in wool with Flanders. In the first part of the war Edward III won a series of brilliant victories which forced the French King to cede to him a large amount of French territory. When France later renewed the war, it went against the English. Their extensive holdings in France were reduced to coastal strips.

RICHARD II had a long minority which resulted in the usual factions and disorders. Some years after he became of age, he began to rule without Parliament and so arbitrarily that his cousin, Henry of Lancaster (*see* HENRY IV), was able to stir up revolt and secure his deposition.

During this century Parliament developed rapidly. It strengthened its control of the grant of taxes and used this power to bargain with the King. Edward III, whom the war placed under heavy pressure for funds, granted to Parliament many requests for power and for legislation. In 1376 Parliament established a precedent for the impeachment of the king's advisers. During this period the knights, who represented the rural districts and were influential socially, and the representatives of the towns, who possessed fluid capital, made it a practice to sit together and apart from the lay and spiritual barons. The combination gave much strength to the body which grew into the House of Commons, though the barons who later formed the House of Lords remained the more influential during the century.

Economically and socially the 14th century was a period of stress and strain. The growth of money economy resulting from increased trade caused extensive changes in the organization of manors which had formerly been units nearly self-sufficient economically. Most notable of the changes was the greater economic freedom obtained by many villeins through the commutation of their services in labor to rents in money. Possibly the process was hastened as a result of the heavy mortality caused by the BLACK DEATH, a plague which swept over England in 1349. The peasants meanwhile became dissatisfied with

their condition. Rural wage-earners resented an attempt to prevent by statute the rise of wages attending the scarcity of labor caused by the Black Death. Villeins demanded their freedom, and those who had commuted their services complained that their rents were too high. The heavy taxes levied for the war contributed the spark that lighted the flame of the peasants' revolt in 1381. The movement was unsuccessful. Commutation, however, did not stop. By the close of the 15th century villeinage had become exceptional.

The Church did not escape the effects of the general spirit of unrest prevalent in England. The sentiment against some aspects of papal intervention in English affairs, which had long been growing, found expression in several statutes limiting the exercise of certain papal powers in England. A popular feeling that the English clergy were abusing some of their powers was given expression by JOHN WYCLIFFE. When he advanced to attack the papal headship and fundamental doctrines of the Church, he lost his support. The few who followed him into heresy were finally forced to forego the expression of their opinions by the persecution of the Church assisted by the State, though it is possible that their beliefs were kept sufficiently alive through underground channels to have had some influence in the production of the PROTESTANT REFORMATION.

House of Lancaster, 1399-1461. Henry IV, who began the rule of the HOUSE OF LANCASTER, was declared King by Parliament. Since another possessed a better hereditary title, he had to meet several rebellions. His success established his house securely upon the throne.

HENRY V, taking advantage of internal dissensions in France, renewed the HUNDRED YEARS' WAR, which had long languished. By winning the northern part of France he forced a treaty which acknowledged him to be the heir to the French throne. Though he died prematurely, leaving an only son who was an infant, the war continued. The steady progress of English arms was finally stopped by the French under the inspiration of JOAN OF ARC. Thereafter the tide turned. In 1453, when the last battle of the war was fought, the English were left in possession only of Calais.

Before the foreign war closed, the English were drifting into the civil wars called the WARS OF THE ROSES. For a long time many English nobles had been keeping in times of peace the large bands of retainers originally raised for war. These bands committed depredations, terrorized the countryside, and bribed or overawed the courts before which they were brought for trial. The Government was unable to maintain order, and the anarchy drifted into civil war. Since the Duke of York, the leader on one side, had a better hereditary claim to the throne than HENRY VI, who was the nominal leader of the other, the war became a dynastic contest for the Crown, with little of popular interest at stake.

House of York, 1461-85. In 1461 the victory of the Yorkists placed EDWARD IV upon the throne. So

disturbed did conditions remain for many years that on one occasion he was driven from the throne for a short interval. Only in the later years of his reign did he restore some semblance of order. On his death, his brother, Richard, became regent. Not content with this position, he procured the murder of Edward's young sons and took the throne. Not for long did he keep his ill-gotten gains. In 1485 Henry Tudor (*see* HENRY VII), who possessed Lancastrian blood, raised the standard of revolt. On Bosworth Field Richard lost his life and the rule of the house of York came to an end.

Parliament under the Lancastrians continued to increase its powers and to define its rights. Representation in Parliament came to be more highly valued, though it is probable that the Lords generally dominated the Commons much of the time. Edward IV, by devising methods of obtaining money without Parliamentary grant, rendered himself somewhat more independent of Parliament than his predecessors had been.

Under the Tudors, 1485-1603. Henry VII, whose title to the throne rested upon conquest followed by Parliamentary grant, rendered his position secure by quelling three serious rebellions. By a marriage alliance with Spain, for which he paid the price of a brief war with France, and by skillful diplomacy, he won recognition of the HOUSE OF TUDOR and restored the prestige of England abroad. At home he strengthened the executive and judicial branches of the Government, sometimes in arbitrary ways, and somewhat at the expense of the power of Parliament. By these means he gave to his subjects the much appreciated boon of law and order. His extensive encouragement of commerce won for the House of Tudor the loyal support of the commercial class, which was growing rapidly in wealth and importance.

HENRY VIII began the ecclesiastical change which ended in the Protestant Reformation. In 1527 he sought the nullification of his marriage with Katherine of Aragon in order that he might marry Anne Boleyn. When he failed to obtain the necessary decree from the papal court, he summoned Parliament. From it he procured legislation which removed the English Church from papal control and placed it under the headship of the king. This step was followed by the dissolution of monasteries and the translation of the Bible into English. There Henry stopped. With impartiality he put to death those who maintained the papal headship and those who denied other significant Catholic doctrines.

The government of Henry VIII was somewhat arbitrary. After the separation, Henry, fearful of popular opposition, had treason defined so broadly that almost any criticism of the king could be brought within its scope. Several executions took place under the act as the result of information supplied by spies set to watch for disaffection. Several of his executions appear to have been no more than judicial murders. Over Parliament he exerted a large measure of control. His frequent use of Parliament, on the other

hand, tended to enhance its importance. At the same time the balance of power in Parliament was swinging from the House of Lords to the House of Commons. Henry's tyranny, moreover, was felt by a comparatively small group. To the rank and file, his strong government brought an even-handed administration of justice and a measure of tranquillity that a weaker ruler could not have provided for a people undergoing the throes of great religious, intellectual, economic and social changes.

The change to Protestantism was completed during the reign of EDWARD VI by Acts of Uniformity, which required the use in every church of prayer-books based in part on the new Protestant doctrines. MARY I restored the papal headship and the Catholic doctrine, burning at the stake those who refused to accept them. The Elizabethan (*see* ELIZABETH) settlement of 1559 placed the Anglican Church again under the control of the Crown and rendered the doctrine finally Protestant. In the course of Elizabeth's reign, opposition to this settlement developed not only from Catholics but also from Protestants who regarded the Established Church as too moderately Protestant. Among the latter, who are often designated indiscriminately as PURITANS, there were two groups. One desired to remain within the new Church and to purify it of forms and ceremonies that savored too much of Catholicism; the other sought to set up independent Protestant churches such as the Presbyterian. The Government persecuted with impartiality either Catholic or Puritan who sought to overthrow the Government of State or Church.

Elizabeth faced grave dangers of foreign attack. Since Catholics did not acknowledge the annulment of the marriage of Henry VIII with Katherine of Aragon to have been legal, they regarded Elizabeth, the daughter of Henry VIII and Anne Boleyn, as illegitimate. In their view Mary Stuart, descended from Margaret, the sister of Henry VIII, should be the Queen of England. Mary was the reigning Queen of Scotland, and early in Elizabeth's reign her husband became King of France. England was saved from a Franco-Scottish invasion by a Protestant revolt of the Scots and by the premature death of the French King. Mary, however, continued to be a source of danger. On the continent a militant Catholic movement was developing which aimed to bring Protestant lands back to the Catholic fold. Mary utilized this favorable situation to seek the armed support of a continental Catholic power for her claim to the English throne. She wrought her own undoing by alienating the sympathies of her Scottish subjects to the point of rebellion. When the storm came, she fled to England, where, after years of confinement within the grounds of a castle, she was executed for complicity in a Catholic plot to assassinate Elizabeth.

After Mary's fiasco, PHILIP II of Spain gradually became the principal enemy of England. Spain was the leading Catholic power, England the leading Protestant power. Elizabeth gave aid to the Dutch Protestants who were in revolt against Philip's rule.

On the sea English sailors were breaking the monopoly of trade maintained by Spain with its colonies, attacking Spanish colonies and seizing Spanish treasure ships. The crisis came in 1588, when the English sea-dogs defeated the fleet sent by Philip to invade England. The victory over THE ARMADA humbled Spain, gave courage to the Protestant cause throughout Europe, and secured for England the position on the sea which made possible the foundation of the empire already envisaged by Englishmen.

The 16th century witnessed the extensive transformation which marked the transition from medieval to modern times. Besides the religious revolution, there was the intellectual development known as THE RENAISSANCE. Late in the 15th century several English scholars who had studied with Italian humanists began to set up new standards of scholarship in English universities and schools. They emphasized the right of the individual to think for himself and subjected authority to rational criticism. In literature the new spirit came to fruition in the age of Shakespeare. Its effect, however, was not confined to intellectual pursuits. The new conception of life gradually permeated all classes of society and found expression in the actions of men in many fields.

The economic changes were tremendous. The geographical discoveries produced new commerce, new commercial methods and new routes of trade. A vast increase of fluid capital had far-reaching results. In England it caused an attempt to use land for a profit rather than for the mere subsistence of the people who lived upon it. Because wool was profitable, many manors were enclosed to make them into pastures for sheep. The ejected tenants often became homeless vagrants. Rents were raised. The increasing supply of precious metals caused the prices of commodities to rise much faster than wages. Progressive debasement of the coinage begun by Henry VIII intensified the evil. The resultant distress was at its worst in the middle of the century, when it caused a popular uprising. Elizabeth restored the coinage, regulated hours, wages and other conditions of labor, enacted the law which remained the basis of public poor-relief until 1834, and encouraged trade and industry. By the closing years of her reign, the economic transition was well on the way to completion and prosperity reigned.

Under the Stuarts, 1603-1714. JAMES I, who was King of Scotland, came to the throne of England a pronounced believer in the theory of divine right. The king, he asserted, was accountable only to God. He was above the law. Parliament and the other organs of Government derived their power from him. He sought to increase the strength of the strong monarchy built by the Tudors. Since the internal difficulties and the dangers of foreign invasion which had caused the nation to feel the need of strong leadership in the 16th century were now gone, Parliament opposed the King. The result was a prolonged struggle between the two.

The main issue was on constitutional questions.

James asserted that the privileges of Parliament, such as freedom of speech, were held of his favor; Parliament claimed them as a right. Parliament tried without entire success to recover its control of the grant of taxes, which had been impaired under the Tudors. The King dismissed judges who would not decide constitutional issues according to his will; Parliament revived the long disused practice of impeaching the King's advisers.

Questions of policy also provoked disagreements. The Puritans, who were becoming influential in Parliament, opposed James's rigid enforcement of conformity, resented his lack of sympathy for the moral reforms they desired, and thought him too tolerant of the Catholics, whom they feared. James's negotiations for a marriage alliance with Catholic Spain were thoroughly unpopular.

By the end of James's reign, the relations between King and Parliament were badly strained. CHARLES I failed to ease them. He asked Parliament to provide money for England's entry into the THIRTY YEARS' WAR on the Protestant side. The cause was not unpopular; but Parliament wanted war by sea against Spain, while Charles entertained grandiose plans of war by land in Germany. Since Parliament granted but little money, Charles tried to exact forced loans from his subjects. Attacks upon Spain and France were unsuccessful because he lacked resources sufficient to equip his expeditionary forces adequately. In the Parliament of 1628 popular displeasure found vent in the PETITION OF RIGHT. This document was second only to the Great Charter in importance. When further differences arose, Charles dissolved Parliament. He did not meet it again for 11 years.

Charles's personal rule evoked a rising tide of popular opposition. Charles devised ways of raising money without Parliamentary grant. Of ship-money, previously used to meet the emergency of a threatened attack by sea, he made a regular tax. He was sustained therein by the decision of a subservient court. Men began to fear the establishment of an irresponsible despotism that would leave the subject without rights against the King. At the same time Charles was pursuing a most unpopular ecclesiastical policy. He supported within the Church a small group which desired to pattern the observance of the Anglican Church more closely upon that of the Catholic. The innovations of this group offended not only the Puritans but also many who were loyal to the Established Church. The popular fears finally found tongue when Charles attempted to force the use of an Anglican prayer-book upon the Scottish Church. The Presbyterians of Scotland defied the royal mandate. When Charles tried to raise an army to enforce obedience, his financial system failed. In 1640 he was compelled to summon Parliament.

This Parliament came to be known as the LONG PARLIAMENT. In its early days an overwhelming majority agreed that the agencies by which Charles had maintained his tyranny must be removed. It forbade further taxation without Parliamentary consent, abol-

ished courts, such as the star chamber, which tried cases without a jury, provided for the regular meeting of Parliament in the future, and prohibited the dissolution of the existing Parliament without its own approval. Thereafter agreement ceased. One group wanted to render the King subordinate to Parliament and to abolish the Established Church; another thought the King had been shorn of enough power and preferred merely to eliminate from the Established Church the recent innovations. In 1642, when the latter group finally came to the support of the King, the outcome was civil war.

The Parliamentarians controlled the portion of England richest in resources; they obtained the alliance of the Scots, and in OLIVER CROMWELL they possessed the best commander. By 1646 the royalists were so utterly defeated that the King surrendered. Peace was difficult to make, because the conquerors did not agree among themselves. A majority in the Long Parliament wanted to establish a Presbyterian State Church; Cromwell and a majority of the army wanted each congregation to be free to worship according to such Puritan practices as it might prefer. Charles played one faction against the other until he finally obtained the help of the Scots to renew the war. Cromwell quickly defeated the Scots. His victorious army returned fully determined to settle with both Parliament and King. By force of arms they ousted the Presbyterian members of Parliament. The remnant of the original House of Commons now left in the Long Parliament was dubbed the Rump. (*See RUMP PARLIAMENT.*) It forthwith decreed the execution of Charles I and established the Commonwealth.

Nominally a republic, the new Government was really controlled by the army led by Cromwell. The COMMONWEALTH suppressed rebellions in behalf of CHARLES II in Ireland and Scotland, and waged a successful war with the Dutch, who had become England's chief commercial rivals. Yet it was never popular. Englishmen were not willing to accept a republic forced upon them by the sword. Eventually the Rump became so obstinate that Cromwell drove it out. The republican Protectorate which followed was no more popular, and Cromwell, in his efforts to maintain religious toleration and political liberty, finally became as arbitrary as Charles I had ever been. After the death of Cromwell the PROTECTORATE soon crumbled. In 1660 the English people restored the Stuart line in the person of Charles II, because experiments in republicanism had taught them that a monarchy was the only form of government on which they could all agree.

The political settlement of the Restoration swept away the republican experiments, but preserved the constitutional reforms made by the Long Parliament before the outbreak of the civil war. It left King and Parliament approximately equal powers in the Government. The religious settlement established the Anglican Church again, and provided for the persecution of Protestant dissenters and Catholics.

Attempts of Charles to secure toleration for dis-

senters and Catholics, combined with his friendliness for Louis XIV of France, the most powerful Catholic ruler in Europe, gradually roused popular apprehension of the King's intentions with regard to Catholicism. It was largely in association with these questions that the first permanent political parties of modern times originated. The Tories supported the Anglican Church and a wide royal prerogative; the Whigs believed in toleration for Protestant dissenters and the superiority of Parliament. When the Whigs obtained a majority in Parliament, they attempted to exclude James, the King's brother and heir, from the succession to the throne, because he was a Catholic. They failed because the unreasoning height attained by the popular fear of Catholicism subsided, and a growing apprehension that departure from the hereditary line of succession would result in civil war took its place. When Charles II died, JAMES II succeeded without any significant opposition.

Though James made a good first impression, he soon raised fears that he intended to establish a Catholic despotism. He increased the size of the standing army, appointed Catholics to office in defiance of the law, secured a decision upholding his appointments from a packed bench, and lifted the ban on Catholic worship by royal decree. The climax was reached when the birth of a son to James assured a Catholic succession. When James came to the throne his only children were two Protestant daughters. When the hope of a Protestant succession vanished, prominent leaders of both political parties invited William of Orange (*see WILLIAM III*), the ruler of the Netherlands and the husband of Mary, James's older daughter, to come to England in arms to help the English overthrow James. When William landed in 1688, James found himself with so little support that he fled to France.

William invited the constituencies of Parliament to elect representatives, and the body which assembled was practically though not legally a Parliament. It declared James to have abdicated, offered the Crown to William and Mary (*see MARY II*), and fixed the succession in ANNE, Mary's sister, and her heirs, if the heirs of William and Mary should fail. The BILL OF RIGHTS which arranged the succession also declared illegal for the future specified arbitrary acts of James. By the acceptance of the Crown, the new rulers agreed to these limitations upon the power of the Crown. These events constituted the revolution of 1688. It settled once and for all that the king was inferior to Parliament. So was ended the danger of despotic government faced by the English people throughout the 17th century. Supplementary legislation completed the settlement. The Toleration Act of 1689 virtually gave freedom of worship to all except Unitarians and Catholics. In 1701 the ACT OF SETTLEMENT conferred the Crown, in the event of the failure of the heirs of both Mary and Anne, upon the electress Sophia of Hanover and her heirs. She was a granddaughter of James I and the nearest Protestant descendant of the House of Stuart.

During the reigns of William and Anne, the foundation of cabinet Government began to be laid. Though the revolution made Parliament superior to the King in the last analysis, the King was still the executive with wide powers. Nothing ensured harmony between the two in the daily work of government. William, indeed, met a discouraging amount of opposition from Parliament. In the party strife between WHIGS and TORIES, which had now become an essential part of the procedure in the House of Commons, William's requests for the appropriations or legislation needful to carry out his policies often failed. To William it appeared that the national interest was being sacrificed to considerations of party. On two occasions he remedied the difficulty by selecting his cabinet of advisers from among the leaders of the party which had the majority in the house. The party would follow their leaders, and so the national business would get done. Previously the members of the cabinet had been regarded as the personal servants of the King without any necessary relation to Parliament. Anne, rather against her inclination, was once forced to take into her cabinet leaders of the majority whom she did not like, in order to prevent a deadlock with Parliament. By the close of her reign, it was reasonably well assured that the members of the cabinet should be leaders of the majority in Parliament, though a long development was required before the cabinet came to wield the powers of the Crown with responsibility only to the House of Commons, leaving the King a figurehead.

Union With Scotland. In 1707 union with Scotland was effected. The crowns had been united since 1603, and in 1689 a majority of Scots accepted William and Mary as rulers. In 1703, however, the Scots made the succession to their throne different from that to the English throne. It was an expression of friction between the two kingdoms for which there were many causes. The Parliaments of the two kingdoms finally agreed to the union which established the kingdom of Great Britain with a single Crown and Parliament, but left to each country its local political, legal and ecclesiastical institutions.

After William came to England, he soon sought to involve the country in a general European war, in which the Netherlands were already opposed to France. Among several factors which induced Parliament to answer favorably, English rivalry with France over sea-power, colonies and commerce was the most influential. The colonies founded in America and the trading-posts established in India during the course of the 17th century had become profitable sources of trade. Earlier in the century the Dutch had been the principal commercial competitors of the English; but by 1689 Dutch power had declined and France stood forth as England's foremost rival. The trinity of sea-power, colonies and commerce not only brought England into the war in 1689, but it also caused England to oppose France in a series of European wars that lasted intermittently till 1815.

In the war begun in 1689, England fought mainly

in Ireland, the Spanish Netherlands, and on the sea. The outcome was practically a draw, and the settlement was indecisive.

In 1701 war broke out anew over a disputed succession to the Spanish Crown. Louis XIV of France sought the throne for his grandson. The English, fearing that the navies and colonial empires of France and Spain would be united, joined the allies against France. The English were led to victory by the DUKE OF MARLBOROUGH at Blenheim and in a number of other battles. General peace was made at Utrecht (*see* UTRECHT, TREATY OF) in 1713. Great Britain secured Gibraltar, Minorca, lands in America, and a limited right of trade with the Spanish colonies. The peace left Great Britain commercially supreme.

Eighteenth Century. GEORGE I, who began the rule of the House of Hanover, was met with rebellion. On his accession he appointed a Whig cabinet, which obtained a majority in the election of 1715. Several of the displaced Tory ministers, in accord with the standards of bitter party strife then current, were impeached. Driven by despair many Tories joined the JACOBITES, who remained loyal to the House of Stuart. The Jacobite rebellion which followed in 1715 was poorly organized and easily quelled. Enough Tories were tainted by connection with it to give to the Whigs a political ascendancy that they maintained for many years. Despite this immediate result, the Jacobites remained a threat to the established Government till the middle of the century, because George I and GEORGE II were regarded as foreigners and were never popular.

The first great leader of the Whigs during this period was Sir ROBERT WALPOLE. Between 1721 and 1742 he established himself so dominantly as head of the cabinet that he is usually termed the first prime minister. He upheld the principle of the unanimity of the cabinet. By presenting to the King the united advice of the cabinet, he made it difficult for the King to refuse that advice. If the cabinet was insistent, the King could refuse only if he could obtain a new cabinet. Walpole rendered that difficult by keeping a close control of the majority in the House of Commons. Though his control rested largely on bribery and corruption, it was no less effective constitutionally. As long as he could marshal the votes, no cabinet other than his could get business transacted in the House of Commons. So, in practice, much of the power of the Crown passed from the King to the cabinet.

Walpole established the House of Hanover securely upon the throne. With mob violence common and the Jacobites hovering in the background, an attempt to overthrow the unpopular Hanoverian monarchy was an ever-present danger. Walpole re-organized the national finances and revised the customs to the advantage of British trade. Since his first care was to avoid antagonizing any large element in the community, his policy was largely negative. His foreign policy was of the same stripe. He used diplomacy to keep Great Britain free from the

wars taking place on the continent. It was on this policy that he was finally defeated. The opposition obtained enough popular support to force Walpole into a war with Spain for commercial reasons. The war soon merged into a general European war fought nominally over the Austrian succession. When the war went badly for Great Britain, Walpole lost his majority and resigned.

Contemporaneously with Walpole's ministry, JOHN WESLEY was taking the leadership of the Methodist movement, which produced a great religious revival in England. After the religious troubles of the 17th century, the religion of the Established Church tended to become cold and formal. Large masses of the people became apathetic. John Wesley, assisted by his brother and others, began to preach to the people whom the Church did not reach. His fervent appeals to the emotions won thousands of followers, whose organization resulted in the establishment of the Methodist sect. The success of the movement eventually stirred the Church to make a stronger spiritual appeal. Before the close of the century, a decided improvement in the moral and social tone of the community became observable.

Of Walpole's successors the first to stand out prominently was WILLIAM PITT (1708-78). He was brought to power by the SEVEN YEARS' WAR. The WAR OF THE AUSTRIAN SUCCESSION was concluded in 1748 without decisive results. As a consequence, when the British and French colonists in America came to blows in their contest for possession of the Ohio valley, not only Great Britain and France but also the other principal powers of Europe were soon involved. When the war began, the weak and inefficient Duke of Newcastle was at the head of affairs. As the war went steadily against the British, the public demand for a better leader grew so strong that the King and Newcastle were compelled to give heed. Pitt, who was one of the greatest orators the House of Commons had yet heard, and in whom the public had confidence, was selected. A cabinet was formed in which Pitt directed the war, and the duke managed the votes in the house. Pitt proved himself to be a great war minister. Under his guidance and inspiration British arms turned back the tide of defeat and won a steady series of victories on land and sea. When peace was made in 1763, the greater part of the French empire in America was transferred to Great Britain, the British were dominant in India, and Great Britain was the foremost colonial power in the world.

This vast empire was soon disrupted by the American Revolution. (See REVOLUTIONARY WAR.) The Seven Years' War created many new imperial problems. The new territory had to be governed and defended. The war also brought to the attention of British statesmen the lax enforcement of the Acts of Trade. These laws, passed mainly in the 17th century, were designed to give to Great Britain a monopoly of colonial trade. After 1763 the British Government began to enforce the Acts of Trade

more strictly and to impose taxes upon the colonists to provide part of the cost of a standing army stationed in the colonies for their defense. The opposition of the colonists grew till it ended in revolution. The French, seeking revenge for the humiliation of the Seven Years' War, came to their aid. The British were defeated. In 1783 they acknowledged the independence of the colonies.

When GEORGE III became king, he attempted to recover the royal authority that had been lost to the cabinet. He took advantage of the division of the Whigs into factions, used the royal patronage to build up in the House a group that would vote as he directed, and played upon differences of opinion within his cabinets. By these means he broke up the party system sufficiently to enable him to dismiss cabinets which could not be induced to follow his wishes. After a decade of these manoeuvres, he obtained a Tory cabinet under LORD FREDERICK NORTH which carried out his ideas. This attempt to undermine cabinet government was defeated by the loss of the American colonies. Public opinion held the King largely responsible for the outcome and turned against him. Laws were passed to end much of the corruption on which the royal influence in the Commons rested, and North resigned. In 1784 WILLIAM PITT (1759-1806), the son of the war minister, became head of a cabinet which, though personally congenial to the King, could not be dominated by him. Thus the cabinet system of government became an established part of the English constitution.

In the second half of the century began an economic revolution which changed living conditions profoundly. The medieval methods of agriculture which still obtained were completely transformed. The system of intermixed strips was gradually given up, and the land was redistributed to give each owner a compact holding. The techniques of agriculture and stock-breeding were improved in many ways. The result was a large increase in the yield of the land. In manufactures a long series of mechanical inventions produced machines which augmented vastly the amount that a worker could produce with the same expenditure of time and physical energy. Because many of the new machines required artificial power to run them, they were grouped in factories, where the wheels were turned by water power or by the newly perfected steam engine. To provide better means of transportation roads were improved and a network of canals was built.

These changes made possible an enormous increase of production at a much lower cost for each unit. British commerce and British wealth increased accordingly. Capitalistic organization of industry became the rule, and capitalists became influential socially and politically. The changes that brought prosperity to many brought misfortune to others. The laborers by hand could not compete with the machines. They lost their means of support. The laborers in the new factories were economically more dependent upon their employers than the laborers

under the domestic system had been. Through a long period of adjustment, moreover, they had to live miserably in overcrowded tenements amid unsanitary conditions. For the first time the population of England became predominantly urban. Great Britain became dependent upon an outside supply of food; so control of the sea was an economic necessity.

The war which marked the final stage in the long rivalry between Great Britain and France began in 1793. After the outbreak of the FRENCH REVOLUTION, many Englishmen began to fear that the movement would spread to England. When the revolutionists became aggressive and occupied Belgium, the traditional strategic interests of Great Britain in the Channel seemed to be threatened. Great Britain, therefore, joined the Allies that were already at war with France. Pitt, who had been highly successful in the reorganization of the public finances and in the restoration of normal conditions after the war with America, proved to be far less capable as a minister of war than his father had been. The war went so generally against the Allies that by 1797 Great Britain was left the only opponent of France. Neither power could push the war to a conclusion. Great Britain possessed the superior navy, and France the superior army. Pitt subsequently built up two successive coalitions of continental powers against France, which NAPOLEON broke up by rapid victories. Napoleon, unable to meet the British navy, struck at British commerce. By his CONTINENTAL SYSTEM he prohibited the importation of British goods into French or Allied territories. Since he controlled by conquest or alliance the coast of Europe from Russia to the Adriatic, British trade was badly crippled. The damage was not sufficient, however, to force Great Britain to make peace. Meanwhile a British army was sent to aid the Portuguese and the Spanish in their revolt against French rule. After years of fighting, it drove the French out of the Iberian Peninsula. At this juncture other powers joined Great Britain once more, and other subject peoples revolted against Napoleon's rule. The BATTLE OF WATERLOO in 1815 marked the final victory of Great Britain in the greatest war fought up to that time.

An incidental result of the war was the union with Ireland. Part of Ireland had been conquered during the reign of Henry II, the remainder under the Tudors and Stuarts. Late in the 17th century and early in the 18th, the Irish Catholics were subjected to a savage penal code and Irish trade was restricted severely. By taking advantage of the strain upon Great Britain during the American Revolution, the Irish obtained greater freedom of trade and legislative independence. Many causes of friction remained, particularly on the part of the Irish Catholics. In 1798 the Irish, moved by the revolutionary spirit, rebelled. Though the revolt was unsuccessful, Pitt hoped by the ACT OF UNION to remove some of the causes of trouble. By its terms the Crowns and Parliaments were united in the kingdom of Great Britain and Ireland.

Political Democracy 1815-1932. Great Britain emerged from the war victorious but depressed. Due to the economic revolution, foreign trade grew during the war. Manufacturers and agriculturalists were generally, but not universally, prosperous. Business was highly speculative, and taxation was heavy. Wage-earners were generally in distress. Employment was uncertain, wages low, and the prices of commodities high. The dislocation of capital and labor caused by the cessation of war threw England into an economic depression that lasted with slight interruption till 1820. The unemployed, hungry masses demanded reforms, often with mob violence. The reactionary Tory cabinet which held office did little in the way of reform and much in the way of repression of agitation for it.

With the return of prosperity, violent agitation ceased. Changes in the cabinet in 1822 and 1823 brought to office a small but influential group of liberal Tories. Under their leadership many moderate reforms were enacted. The criminal law was revised in a humanitarian spirit. A more liberal commercial policy was inaugurated by the reduction of the duties on several articles. Restrictions on the organization of labor were reduced to permit laborers to unite to secure regulation of hours and wages. Civil disabilities imposed for religious beliefs were largely removed, and Irish Catholics were allowed to sit in Parliament.

The Tories, however, stopped short of the reform of the House of Commons. That issue came to the front in the election of 1830. Because the seats in the House had not been redistributed for centuries, great inequalities existed. Many a town with a ridiculously small population was returning two members, while populous places like Leeds and Manchester were unrepresented. The franchise was so narrow that no more than one of 10 adult males could vote. The inevitable accompaniment of such conditions was corruption at elections. The House was in no wise representative. The Whigs came to office pledged to reform. After a prolonged struggle in Parliament, which caused a constitutional crisis that narrowly avoided civil war, they carried the first reform bill in 1832. It deprived the smallest towns of their representatives and gave them to more populous places. The franchise was rendered uniform and slightly broader. Few laborers were given the vote. Control of the House of Commons was placed in the hands of the middle class.

Thereafter the Whigs carried a sweeping program of further reform. The hours of children in factories, which had been barbarously long, were restricted; slavery was abolished in the colonies; a new poor law eliminated the evils of an old system so administered that it promoted idleness and discouraged thrift, and the municipal governments were taken out of the hands of the irresponsible oligarchies where they were often lodged and placed in control of the resident rate payers. It was also under the Whig administration that was laid the foundation for self-

government in Canada, whence the principle spread to the other colonies inhabited by large European populations.

Sir Robert Peel, who became head of a Conservative (Tory) cabinet in 1841, virtually established free trade. In two revisions of the tariff, he made extensive reductions. The CORN LAW, which placed a high protective duty on grain, he left severely alone, because his supporters were mainly agriculturalists. The manufacturers and merchants, however, stirred up a wide popular demand for the repeal of the Corn Law which taxed the people's food when industrial products were no longer protected. Peel, already in doubt, was fully convinced of the iniquity of a tax on food by a potato famine in Ireland which caused thousands to starve. In 1846 he swept away the last bulwark of protection by the repeal of the Corn Law.

The repeal split the Conservative Party so badly that Peel was soon defeated. For the next 20 years no party kept for long a stable, substantial majority in the House of Commons. Consequently the period was singularly devoid of important legislation on internal affairs. The events that stood out were the CRIMEAN WAR and the Indian mutiny.

During most of the 19th century, British statesmen had been apprehensive of Russia's aggressions upon the decaying Ottoman empire. They sought to prevent Russian control of the Straits, which would threaten Great Britain's position in the Mediterranean and possibly in India. With this traditional policy in the background, Great Britain, for what appear to have been trivial immediate causes, joined with France in 1854 to make war upon Russia. The campaign in the Crimea, after the incompetency of commanders and the war office had brought much unnecessary suffering to the British troops, netted the Russian forts that were its objective. The peace of 1856 kept Russia from increasing her influence in Turkey and neutralized the Black Sea. Such were the slight advantages received by Great Britain for a costly victory.

The Indian mutiny had for its background the rapid expansion of British power in India. The EAST INDIA COMPANY originally sought only trade in India. When its officials in India began, during the contest with France in the 18th century, to take possession of native territory, they acted contrary to the company's policy. Finally the British Government took from the company control of political affairs in India, in order to ensure justice for the natives and to prevent further expansion. It was all to no purpose. By the middle of the 19th century, the British ruled directly a large portion of India and exercised some measure of control over nearly all the rest. This expansion, together with the reforms introduced by the British, caused the natives to fear that their culture and religion were doomed to extinction. Against this background, the dissatisfaction of the native troops (*sepoys*) employed by the British with recent changes in the requirements of their service was enough to fire the spark of rebellion. The mutiny

was suppressed only with great difficulty. Thereupon the company was deprived of the last of its privileges, and the British Government assumed sole responsibility for the reorganized Government of India.

The period of political apathy ended with the passage of the second reform of Parliament in 1867. It lowered the qualifications for voting sufficiently to enfranchise the urban wage-earners and to send England far along the road to democracy.

Soon after the reform, WILLIAM GLADSTONE and BENJAMIN DISRAELI became the untrammelled leaders of their respective parties. In the election of 1868 Gladstone led a united Liberal (Whig) party to victory. His administration was the golden age of liberalism. To remedy the grievances of the Irish, which were ever recurring to cause English statesmen trouble, Gladstone disestablished and disendowed the Protestant Church in Ireland, and enacted a land law designed to give tenants better protection against unscrupulous landlords. In England he established the first publicly maintained elementary schools, reorganized the courts and reformed their procedure, placed nearly the whole civil service on the basis of competitive examinations, reformed the administration of the army and introduced the Australian ballot.

Disraeli, who brought the Conservatives to power in 1874, though he did not neglect internal affairs, placed the emphasis on imperial questions. He roused in public thought an interest in the empire which had long been dormant and prepared the way for the imperialistic period which followed. By a spectacular purchase of shares in the Suez Canal, which came on the market unexpectedly, Disraeli secured for Great Britain an influential voice in the management of the canal. When Russia defeated Turkey, he persuaded the victor to submit to a revision of the treaty of peace by a congress of the powers held at Berlin, where he obtained what were regarded as advantages for Great Britain. Eventually he alienated his public support, because his aggressive policy involved Great Britain in petty wars in Afghanistan and South Africa which did not redound to the credit of British arms.

Gladstone, who had long talked of Disraeli's unscrupulous aggressiveness, revised the imperial policies of his predecessor where he could, as soon as he came to office for the second time. It was during his administration, nevertheless, that Great Britain took control of Egypt. In Ireland there was much disturbance, despite a second land act which gave the tenants more extensive rights against their landlords. At home the most notable reform was the extension of the franchise to the rural wage-earners, the only large group which did not have it, and a general redistribution of the seats in the House of Commons.

In 1886, when Gladstone became prime minister for the third time, he split his party by an unsuccessful attempt to give home rule to Ireland. Thereafter the Conservatives were in power for 20 years except from 1892-95.

In Ireland the Conservatives, who opposed home rule, began the policy of providing tenants with long loans on easy terms for the purchase of their tenements from their landlords. They also gave to the Irish more municipal home rule and legislated to improve social conditions. They accompanied these policies with the strict repression of disorder. By the turn of the century, Ireland enjoyed greater tranquillity and prosperity than it had known for some time.

In this period imperialism grew rapidly. Great Britain participated with other powers in the scramble for Africa. Not only there, but in other parts of the world as well, friction developed with other European powers which were equally intent upon imperial expansion. The policy led in 1899 to war with the Boers of South Africa (*see* BOER WAR), who were not finally conquered until 1902.

In 1906 the Liberals came to power with the most radical program of social reform that Great Britain had yet seen. Since the beginning of the second era of reform in 1868, both parties had been legislating to improve working and living conditions of urban labor. The Children's Labor Act of 1833 had grown into a whole code regulating the conditions of labor in factories and mines; trade unions had won extensive rights; workers injured in the course of their work could secure compensation in many occupations; some steps had been taken toward providing working men with better homes, and a deal of other beneficent legislation had been enacted in their behalf. Still a large amount of poverty and misery existed in England. The Liberals sought to go beyond palliatives and to remove the causes of poverty and distress. They extended widely the liability of employers for the compensation of injured workmen, established a minimum wage in specified sweated industries, made the Government responsible for the payment of old age pensions, made the Government a contributor to the cost of compulsory insurance of working men against sickness and in a few industries against unemployment, and enacted many lesser reforms. To provide the means for this program, they began to tax the rich to support the poor.

While enacting this legislation, the Liberals met with so much opposition from the House of Lords, where the Conservatives were in a large majority, that they limited the powers of that body. In 1911 the Parliament Act provided that money bills should go to the King one month after they had passed the Commons, and other bills when they had passed the Commons in three consecutive sessions occupying an interval of at least two years. The Lords were left with power to delay but not stop permanently any legislation on which the House of Commons is determined.

Meanwhile the events which led to the European war (*see* WORLD WAR) were taking shape. During the two last decades of the 19th century, Germany, Austria and Italy formed the TRIPLE ALLIANCE, and

Russia and France the Dual Alliance, while Great Britain pursued the policy of splendid isolation. At the end of the century, the friction with continental Powers became so great that British statesmen began to seek friendship with some Power. After an approach to Germany failed, the Entente Cordiale was arranged with France in 1904. All imperial questions which had caused trouble between the two Governments were settled. Subsequently the two Powers acted together diplomatically, and in 1905 and 1906 the naval and military experts of the two countries began conversations about the joint defense of France if that country should be attacked. In 1907 Great Britain established a similar entente with Russia. Thereafter Europe was divided into two armed camps, with the Triple Alliance on one side and the TRIPLE ENTENTE on the other. Whenever relations became strained between any two powers that were on opposite sides, the danger of a general European conflict became imminent. The war came in 1914, when Austria seized upon the assassination of the archduke by Bosnians as an excuse for an attack upon Serbia. Russia supported Serbia, and Germany upheld Austria. All the powers were soon engaged in the war that lasted till 1918.

Great Britain emerged from the war victorious but badly crippled. The LEAGUE OF NATIONS was formed to prevent future wars. Germany was required to pay heavy reparations, and Great Britain obtained mandates from the League over several colonies rich in natural resources. These did not constitute compensation for the losses. Of the British and colonial soldiers, nearly 1,000,000 were killed and 2,000,000 more were wounded. Taxation was heavy, and a crushing burden of debt was left. Great Britain suffered less from inflation than some of the other participants, being able to restore the gold standard after a few years. The dislocation of labor and capital, however, affected Great Britain with its predominant industrial organization more than it did most countries. Unemployment reached huge proportions, and the economic distress of the British people has not yet ceased. The Government tried to assist the unemployed by giving to them a dole, which became an enormous burden on the taxpayer. In 1931, when Great Britain experienced the economic depression that spread over the world, the dole had to be reduced and the gold standard abandoned.

During the war, the electorate was increased largely by simplifying the qualifications for the franchise and by extending the suffrage to women. After the war the British Government met from many of its colonies and dependencies a demand for more self-government. Southern Ireland revolted and obtained in 1922 a position similar to that of the self-governing colonies, with the name of the Irish Free State. India obtained a limited amount of local self-government, but not as much as the natives desired. The Egyptians received a degree of independence that was unsatisfactory to them. The self-governing colonies became autonomous communities, equal in status and

not subordinate to Great Britain. This commonwealth of nations is held together only by a common allegiance to the Crown and by recognition of the value of association in the British Empire.

DAVID LLOYD GEORGE, who led Great Britain through the closing years of the war, remained at the head of a Coalition Government until 1922. When the cabinet resigned, the Liberals had become so irretrievably split that the Conservatives won the election. In 1924 the Labor Party, which had been a significant factor in politics only since 1906, formed a cabinet. Since that time power has alternated between the Conservative and Labor parties. Labor, however, has never had a majority over the other two parties combined, and it has always been dependent on some Liberal votes. The economic crisis of 1931 caused a split in the Labor Party and the resignation of the cabinet. RAMSAY MACDONALD, who had been leader of the Labor Party, formed a coalition cabinet from the three parties, and the greater part of the Labor Party went into opposition. The coalition returned from the election with a huge majority.

W. E. L.

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ENGLEWOOD, a residential suburb of Denver in northeastern central Colorado, situated in Arapahoe Co. Two railroads serve the city. Wheat, beets and alfalfa are the chief crops of the vicinity. The principal industries include iron foundries, dairy and poultry interests and greenhouses. Englewood is the seat of the National Swedish Sanatorium. Pop. 1920, 4,356; 1930, 7,980.

ENGLEWOOD, a residential city of Bergen Co., N.J., situated partly on the western slope of the PALISADES and partly in the valley of the Hackensack River, about 5 mi. northwest of the New Jersey terminus of the George Washington Memorial Bridge. It is served by a line of the Erie Railroad and by motor bus lines. In 1929 the value of local manufactures was about \$1,000,000; the retail trade amounted to \$13,447,946. Englewood became a separate township from Bergen in 1871, and in 1899 obtained its charter as a city. Pop. 1920, 11,627; 1930, 17,805.

ENGLISH CHANNEL, an arm of the Atlantic Ocean, between England and France. It is a comparatively shallow strait reaching from Europe to Greenland; it stretches a length of 350 mi., is joined to the North Sea by the Straits of Dover and meets the Atlantic near the Scilly Isles. Its width varies from 20 to 100 mi., and its area is 30,000 sq. mi. The depth runs from 6 to 500 ft. The south shores are subject to very high tides, the north, to very low, and near Beer Head there is very little ebb and flow. The Channel Islands, the Scilly Isles, and the Isle

of Wight are the larger of its islands. The Seine, from the French coast, is the largest river discharging into the Channel. Its abundant fish provide a livelihood for large numbers of persons both in England and France. Cross currents make the sea unusually rough and choppy and the small passenger boats that ply back and forth from the coast of France are highly unpopular because of it. In fact so uncomfortable is this passage that numerous schemes for connecting London and Paris have included tunnels, bridges and railroad ferries. The principal seaports on the French coast are Calais, Boulogne, Dieppe, Havre and Cherbourg, with Dover, Portsmouth, Southampton, Plymouth, Folkestone and Falmouth on the English coast. The defeat of the Spanish Armada was probably the most memorable of the numerous naval engagements fought in its waters.

ENGLISH DRAMA. See ENGLISH LITERATURE; FOLK DRAMA; MEDIEVAL DRAMA; PRE-SHAKESPEAREAN AND SHAKESPEAREAN DRAMA; RESTORATION AND POST-RESTORATION DRAMA; ENGLISH DRAMA, MODERN.

ENGLISH DRAMA, MODERN. The low estate to which the British drama had fallen at the beginning of the 19th century is attributable to many conflicting causes, graphically set down in Prof. Allardyce Nicoll's *A History of Early Nineteenth Century Drama*. A collection of the worst plays on the London stage from 1800 to 1850—those bad and flimsy melodramas, farces, burlesques and extravaganzas at the start of the Victorian era—and those lifeless tragedies and dull comedies—have a significant meaning in any commentary on the subject. They have their story to tell of romantic violences and cheap humors. The theater in London was left to die by the literary figures of the time, until WILLIAM MACREADY made a stand and encouraged Bulwer-Lytton and Robert Browning in playwrighting. Curiously, the poets of the time, interpreting the theater in their own way, catered to it only half-heartedly, without patience either to learn its technique or to help bring back its glory. They imitated the shell of the past. French and German melodrama flooded England because it could be cheaply procured. In price and sentiment such dramaturgy could be had for the asking.

The first half of the century was the period of the novelist. SIR WALTER SCOTT and his passion for antiquarian lore; DICKENS and his realistic sentiment; and finally THACKERAY—the theater had a fascination for the three; but they never thought seriously of its welfare. Yet, from 1800 to 1850, one must consider the dramatized novel. Everyone seemed wanting to make plays from the Waverley Novels during the second decade of the century; and the next 20 years witnessed the tremendous popularity of Dickens. Was it the folklore love of Scott, the fine humanity of Dickens that appealed? or was it not rather the melodramatic condition of the plot and the Mrs. Radcliffe somberness of the atmosphere which fitted in with the melodramatic influences of French and German importations? The theater of that day derived nothing to speak of from Wordsworth, Coleridge,

Southey, Godwin, Lamb, Shelley or Keats. The theater derived nothing from the English life of the time. It was interested in plots tintured with morbid ROMANTICISM. In fact, a large part of the drama of this period was adaptation; it would seem that this French inroad was a return courtesy for what Scott had done for the French Romantic revival. Boucicault, Wills (1828-91) and Fitzball (1792-1873) fell a prey to the style, and the English stage was deluged with "arrangements" from hack-writers. Hence, in the '40s, one found dramas with such titles as *The Scamps of London* (Moncrieff), *The Mysteries of Paris* (Dillon) and *The Smuggler's Daughter*.

Any modern approach of the English theater, therefore, must begin about 1850. James Sheridan Knowles (1784-1862), John Howard Payne (1791-1852) and J. R. Planché (1796-1880) were the dominant figures of the time. The Kembles, as a family of players, were holding aloft the fire of the actor's art, William Macready was a potent factor in his managerial policy, wherein BULWER-LYTTON (1803-73) and ROBERT BROWNING (1812-89) were his drawing-cards. DION BOUCICAULT (1820-90) wrote *London Assurance* in 1841, and a typical reflection of the good and bad of the era may be found in him. His plays heightened domesticity to a melodramatic pitch; they made use of realism. Note Boucicault's statements regarding the British manager's rush for cheap dramatic labor in 1842. Read through the titles of Boucicault's plays and they reflect the hectic color of the times. It was necessary that the theater be jerked back into reality.

The freeing of the theaters in 1843 did nothing to establish any theater taste, but rather this move invited undisciplined entertainment, easily seen in the burlesques of T. N. Talfourd, Burnand and H. J. Byron (1835-84) and in the extravaganzas of Planché. N. W. Sawyer (*The Comedy of Manners*) quotes Tom Taylor as having said: "The patents were broken down; all the theaters were opened to all kinds of entertainments; actors became scattered; and whatever of artificial or stately in stage art had been maintained by the barriers of privilege, or the influences of tradition, began to melt away, and make room for the ways of acting and forms of entertainment bearing a more popular impress."

The actors of these years gave a new impetus to Shakespearean production. J. P. Kemble (1757-1823), followed by Macready, Samuel Phelps and CHARLES KEAN, began the fashion; and it was maintained later by HENRY IRVING and Herbert Beerbohm Tree (1853-1917). Prof. George C. D. Odell's *Shakespeare from Betterton to Irving* gives the details. Extensive and expensive archaeology, with a Royal Academy scenic background, and further shifting and restoration of Shakespearean texts, were the main features of this stage technique. But there was also the charming Madame Vestris (1797-1856) to be reckoned with, she who truly set the London physical stage on its modern way (consult Rosamond Gilder's *Enter the*

Actress). She fought against the patent theaters, she introduced the habit of careful rehearsal, she had a passion for realism which forced her into heavy expenses as a manageress, and she may be regarded as the mother of the "boxed-in" interiors for stage sets. For the latter innovation alone, the London pit rose to great heights of enthusiasm. Planché's extravaganzas were at first her concern. But Shakespeare, Gay's *The Beggar's Opera*, and Boucicault's *London Assurance* were her triumphs. She helped to give health to a weak and lagging British stage.

The diaries of that cultured snob Macready vividly reflect the atmosphere of the day. Due to him, Bulwer-Lytton produced *The Duchess de la Vallière*, 1836, *The Lady of Lyons*, 1837, and *Richelieu*, 1839; and for him Browning wrote *Strafford*, 1837, and *A Blot on the Scutcheon*, 1843. This strain of poetic contribution to the British theater went through several other generations, encouraged by the actor-manager. Under Irving, ALFRED TENNYSON (1809-92) gave to the stage *Queen Mary*, 1876, and *Becket*, 1893. In the '90s George Alexander (1858-1918), inspired by the success in France of Richepin and Rostand, turned to Stephen Phillips (1868-1915) for drama. But, while he produced that poet's *Paola and Francesca*, an English hamlet idyll, pathetic and haunting in its lines but utterly devoid of the red passion of D'Annunzio, lacking the historical sense of Marion Crawford and the structural effectiveness of Boker, it was Beerbohm Tree who produced Phillips's *Herod*, 1900, *Ulysses*, 1902, and *Nero*, 1906. This stream did not, however, encourage a renaissance of poetic drama on the English stage, even though JOHN MASEFIELD brought his exquisite talent to bear on such a theme as *The Tragedy of Pompey the Great*, and such a local piece as *The Tragedy of Nan*, 1908. In this languishing atmosphere, the torch of old poetic glory was held aloft by William Poë, Ben Greet and F. R. Benson.

One's concern here is with the British theater from the Robertsonian period, or from the era of the Bancrofts—Squire and Marie Wilton—the first realistic players in the modern sense. Marie Wilton's evolution from burlesque is really the evolution also of the English stage of the time. From melodrama, from extravaganza, to the "cup and saucer" quietude of the Robertsonian comedy—is the trend to follow. Where Vestris had aimed for refined realism of an external character, the Bancrofts aimed for inner restraint in realistic acting, which in 1865 made their Prince of Wales's Theatre, London, so distinctive a playhouse. The value of THOMAS W. ROBERTSON (1829-71) is largely dependent on comparison with the theatrical time preceding him rather than with the era to follow. The recollections of Marie and Squire Bancroft reflect all that he attempted to do and had to contend with. Robertson was the author of *David Garrick*, 1864, *Society*, 1865, *Ours*, 1866, *Caste*, 1867, *Play*, 1868, *School*, 1869 and *Home*, 1869. Under the Bancroft sway prospered Tom Taylor (1817-80), H. J. Byron (1834-84), "Wilkie Collins"

(1823-89), and W. S. Gilbert before he made his inimitable union with Arthur Sullivan. Also under the Bancroft régime were cradled the futures of such players as Charles Wyndham (1837-1919), John Hare, Ellen Terry (1848-1928), Forbes Robertson and the Kendals. With the latter began the prolific career of ARTHUR WING PINERO.

Barring the importance to realism of the Robertsonian school of comedy, by far the most significant figure of the time was W. S. GILBERT (1836-1911), not so much because of his so-called serious drama such as *Sweethearts*, 1874, *Charity*, 1874, *Comedy* and *Tragedy*, 1884, and *Engaged*, 1877, or his verse plays, *The Palace of Truth*, 1870, *Pygmalion and Galatea*, 1871, and *Broken Hearts*, 1875, but because of his libretto combination with ARTHUR SULLIVAN, which blossomed in 1875 with *Trial by Jury*, and ran the whole range of melodic irony and fun in *The Sorcerer*, 1877, *Pinafore*, 1878, *The Pirates of Penzance*, 1879, *Patience*, 1881, *Iolanthe*, 1882, *The Mikado*, 1885, *Ruddigore*, 1887, *The Yeomen of the Guard*, 1888, and *The Gondoliers*, 1889. Such a partnership was the distinctive pride of the Victorian drama. Other playwrights of this period were CHARLES READE, Douglas Jerrold (1803-57), Edward Fitzball (1792-1873), J. M. Morton (1811-91), W. B. Bernard (1807-75), J. B. Buckstone (1802-79) and Planché (1796-1880).

The modern view of the London stage begins with the words of MATTHEW ARNOLD, who wrote an essay on *The French Play in London*. It was in this that he exclaimed: "The theatre is irresistible; let us organize the theatre." There is much more than that in Arnold's essay. But people are given to pinning their faith to slogans, and this one rang through several decades after the company of the *Comédie Française* made its auspicious visit to London in 1879. In this company Arnold witnessed the theater working truly as a social institution. He wrote: "I see our community turning to the theatre with eagerness, and finding the English theatre without organization, or purpose, or dignity, and no modern English drama at all except a fantastical one. And then I see the French company from the chief theatre of Paris showing themselves to us in London—a society of actors admirable in organization, purpose, and dignity, with a modern drama not fantastic at all, but corresponding with fidelity to a very palpable and powerful ideal, the ideal of the life of the *homme sensuel moyen* in Paris, his beautiful city. I see in England a materialized upper class, sensible of the nullity of our modern drama, impatient of the state of false constraint and of blank to which the Puritanism of our middle class has brought our stage and much of our life, delighting in such drama as the modern drama of Paris."

HENRY ARTHUR JONES (1851-1929) was 28 when that was written. The date of his first essay in *The Renaissance of the English Drama* is 1883. The entire book, which established Jones as a zealous critic of his contemporary theater, is the preachment of the

theater gospel according to Arnold, with the text: "The theatre is irresistible; let us organize the theatre." Through a lifetime of service, Jones fought for the theater as a social institution. After his death, even his will contained admonitions to the audiences of London. He was an indefatigable worker for reform, and cleared the atmosphere of Victorian cant about many mooted questions of morality. He was a great stickler for words, and spent much time differentiating between entertainment and amusement. To him, dramatic art was always menaced by popular demand. He felt this whenever he went to the theater; he experienced it by the public rejection of many of his serious attempts as a dramatist himself. But he went on mirroring life to the full bent of his limited culture. Note his method in *Saints and Sinners*, 1884, *Judah*, 1890, *Michael and His Lost Angel*, 1896, and *Mrs. Dane's Defence*, 1900—"strong" dramas for their generation, which first opened to the English stage certain taboo questions.

The drama was an educational matter with Jones. In that respect he was Arnold's standard-bearer. His fervor passed into another volume of essays and lectures called *Foundations of a National Drama*. He did much clearing of the way for that new theater organization which was carried out by privately supported societies. Far more effective on the future fate of the British drama was Henry Arthur Jones than WILLIAM ARCHER (1856-1924), the critic and translator of Ibsen.

This was the period in the London theater, therefore, when theater folk were conscious of a real need for an English theater. Not for nothing were the wit and satire of the Gilbert and Sullivan operas written. British class, taste and custom came in for their melodic scrutiny. Jones and Pinero, in their comedies, resorted to satire also. They both had felt the Ibsen impact, and to know what that impact was in London is one of the essential tasks of the student of British drama of the Victorian era (consult Miriam Alice Franc's *Ibsen in England*). The theater catechism of this time was Bernard Shaw's *Quintessence of Ibsenism*, which noted minutely the tremor of British opinion at the appearance of each new Ibsen play. Credit must be given to EDMUND GOSSE and William Archer for the manner in which they fought the fight for the Scandinavian who revolutionized the modern drama of the world. It was the spirit which prompted opposition to Ibsen that was behind the Stage Society movement, behind Shaw, behind all the advanced efforts in the theater that were handicapped by the official censor.

So unique were Jones and Pinero that they occupy a place by themselves, and are usually joined together in a discussion of British drama as Sudermann and Hauptmann are linked in a consideration of German drama. Not that Jones's plays were iconoclastic enough to take them outside the British acceptance; but they were fearless within bounds and brought back to the stage a literary style it lacked in the Robertsonian period. Jones paid attention to play struc-

ture; he set himself a purpose. But his plots did not show a rich narrative invention. Pinero is a far better fictionist than Jones was. Pinero's variety is more extensive. Note his court farces and his so-called social comedies. But Pinero has always been a stage constructionist, not a philosopher. He has never shown so much penetration as Jones has, because Jones, fundamentally, possessed more of a social conscience. Taking Jones on the social side, *The Middle Man*, 1889, presents little of the modern social slant. Undoubtedly his high-water mark is to be found in *Mrs. Dane's Defence*, 1905, and *Mary Goes First*, 1913. Jones's satire is deeper but less brilliant than Wilde's, his humor not so quick.

Pinero's best quality is the virility of his narrative invention. He looked back to Robertson, he was jolted into feminism by Ibsen, he was kept in the theater by the fact that, as an actor, he came from the theater. He was more prolific than Jones because he has never been disturbed by a critical conscience. But he knew his stagecraft. Read his farces, *Dandy Dick*, 1887, *The Cabinet Minister*, 1890, and *The Amazons*, 1893, and measure the light agreeableness of his humor. There followed the era of *The Second Mrs. Tanqueray*, 1893, and *The Notorious Mrs. Ebb-smith*, 1895. Merely running through the titles of his plays brings back memories of sheer entertainment in the theater. Pinero never set out to be an interpreter. Sometimes he preached in set speeches, as, for example, in *Midchannel*, 1909. He told his story with relish and made his characters live, not by any too deep discernment or demand upon them, but by sheer expertness in handling theater situation and in sensing dramatic values; there is not a play of his but has that quality of an eye for the dramatic. The effective appeal is to be found in such of his plays as *Trelawney of the 'Wells'*, 1898, *The Gay Lord Quex*, 1899, *Iris*, 1901, *His House in Order*, 1906, and *The Thunderbolt*, 1908.

These two dramatists, Jones and Pinero, ushered in what Holbrook Jackson has written about in his delightful volume, *The Eighteen Nineties*. They were a part of this era, and yet they were apart from it. OSCAR WILDE (1856-1900) was a figure, however, typical of the art movement of these years. A combination of Irish temperament and of French technique, of individual wit and weakness of will epitomizing a certain esthetic fashion that seized England in the '90s, Wilde was preeminently the pose and *poseur* of his day. *Lady Windermere's Fan*, 1892, *A Woman of No Importance*, 1893, and *The Importance of Being Earnest*, 1895—all contain about them the touch of estheticism. Just as Haddon Chambers (1860-1921), H. V. Esmond (1869-1922), and R. C. Carton (1856-1928) came from Jones and Pinero, so Somerset Maugham (1874-) came from Wilde, and Noel Coward (1899-) came from Maugham. This stream of similar technique, which one delights in "pigeonholing" into schools, must be measured. Sometimes it is mere imitation, sometimes it is temperamental. Is there, for instance, any sign or

token which would differentiate the temperament of Langdon Mitchell in *The New York Idea*, 1906, from Maugham in *Our Betters*, 1917? Yet, what is there in both American and Englishman that relates their wit to the Restoration, or even to the later Sheridan period?

Somerset Maugham's genuine ability in the handling of the comedy of manners is best seen in his excellent *Our Betters*, 1917, and *The Circle*, 1921. In plot he is reminiscent of, though not as strong as, Pinero. The wit, which he has always handled with realistic excellence, has been carried forward by Noel Coward into a post-war world, where young men and women have been made conscious of belonging to a "younger generation." Coward has exalted frivolity, a temper such as one finds in his *Vortex*, 1925, *Easy Virtue*, 1926 and *Private Lives*, 1930.

Notwithstanding Wilde and Maugham, the comedy of manners has fared badly in recent years on the British stage. Sawyer attempts to explain this by saying that "It cannot, in the historic sense, be looked for in the nineteenth century as a representative type of comedy. It may and does occur sporadically either as a quaint revival, an antique like its costumes and furniture; or as the picture of a contemporary aristocracy which still exhibits, now and again, the spectacle of a *beau monde*. As the reflection of the life of a unified, homogeneous, and imperious class, in which manners are crystallized by precedent and sanctified by custom, it does not exist, except as an occasional anomaly."

Holbrook Jackson in *The Eighteen Nineties* epitomizes the culture of an entire period. Pinero and Jones were young during this time. In 1890, Rudyard Kipling was young, J. M. Barrie was beginning, H. G. Wells was publishing his scientific romances. Through romance, reality was breaking in. And Ibsen was the terror. The FABIAN SOCIETY was the school of politics for the young men. WILLIAM MORRIS had started the Arts and Crafts movement, G. B. S.—familiar initials—was chanting the praises of vegetarianism and, in his *Saturday Review* drama notes (afterwards gathered into his significant volumes, *Dramatic Opinions*, 1907, of which Max Beerbohm's *Around Theatres*, 1930, is a second best), was sounding a clear call for better drama; while, in his *Quintessence of Ibsenism*, 1891, he was declaring himself an ardent disciple of the thesis play. J. T. Grein in 1892 produced *Widowers' Houses*, and thus began the "special performance" salvation of the British drama, which resulted in all the special institutions to which London's "modern drama" owes such a debt of gratitude.

Of these special theater institutions, there were several with significant histories. First came Grein's Independent Theatre in 1891. It had received its inspiration from the *Théâtre Antoine* in Paris and the *Freie Bühne* in Berlin. It had the enthusiastic support of George Meredith, Thomas Hardy, Pinero, Jones, Archer, Warkley and Shaw. It afforded London an opportunity to judge dramatists of the Continent: Ibsen, Brieux, Gorky, Tolstóy, Wedekind,

Chékov, Hauptmann, Gogol, Currel, Schnitzler and Strindberg. In such an atmosphere Gilbert Murray's Greek translations prospered.

Then, among the special institutions came the Elizabethan Stage Society, 1895, and the Stage Society, 1899, with their invigorating "first performances" and revivals. The Court Theatre followed in 1904, under the combined management of Vedrenne and H. Granville-Barker, in the repertory of which there figured Galsworthy, Shaw, Barrie, Barker and Meredith. CHARLES FROHMAN, the American theatrical magnate, now caught the fever, and in a rash moment, established a repertory theater in 1910, characterized by interesting programs of an uncommercial character, and doomed to failure, as P. P. Howe has analyzed in a book on the subject. Local repertory theaters sprang up. In Dublin, the Abbey Theatre established a standard and revived national pride. (See IRISH THEATER.) One began hearing of the Manchester, the Birmingham, the Liverpool repertory theaters, of the Welsh National Drama Company and the Scottish Repertory Company. Personalities came to the fore in such theater groups, and worked significantly. Yeats's Irish Theatre and the Manchester Repertory Theatre are linked together in mind through the common patronage of Miss A. E. F. Horniman, who began mothering repertory as early as 1894. More recent history has been made, under the direction of Barry V. Jackson and John Drinkwater, in the Birmingham Repertory Theatre.

During the time of these experiments, the great potential power of the London theater was HARLEY GRANVILLE-BARKER (1877-). The training and inspiration he obtained through the Stage Society and the Elizabethan Stage Society, placed him in the forefront of the few directors of classic drama in England. Through his efforts many of the Shakespearean comedies received new and refreshing interpretation and, when he came to America, converting college athletic stadia into Greek stages for Murray's renderings of Greek tragedy, he showed a distinguished hand. A tutelary light of Shaw when he became playwright, Granville-Barker showed a meticulous intellectualism which was developed through a realistic style. *The Madras House*, 1910, is a triumph of the "slice of family life" drama, while *The Voysey Inheritance*, 1905, is his most complete play from the standpoint of telling a story. He has expended much effort in other directions, but always his interest has centered seriously on the theater. With William Archer he wrote a carefully conceived treatise, *Schemes and Estimates for a National Theatre*, and it was on the strength of this partly that he was called to New York to take charge of an idealistic "New Theater" which he refused, and which later met with an untimely end because of certain fundamental blunders committed at the beginning. He has made many adaptations, the most noteworthy being Schnitzler's *Anatol*, and, in recent years, he has occupied his time making translations from the Spanish of the dramas of Sierra.

A. E. Morgan puts under the heading of "The Drama of Revolt" in *Tendencies of Modern English Drama*, Stanley Houghton (1881-1914), author of *The Younger Generation*, 1910, and *Hindle Wakes*, 1912; Elizabeth Baker, who wrote *Chains*, 1909; Githa Sowerby, author of *Rutherford and Son*, 1912. In this class may also be accounted Harold Brighouse (1882-), Charles McEvoy (1879-1929), whose *David Ballard*, 1907, is a model of realistic treatment, and Allan Monkhouse. These are all products of "repertory fervor," and are triumphant in motivating middle class ideas and ideals. This realistic treatment of character and expression has been carried to its highest pitch in the work of C. K. Munro (1889-), who wrote *At Mrs. Beam's*, 1921. Here he has piled on the agony of realism by making his plays dull because he wants, through the sheer excess of dull dialogue, to show what dull, futile people he is writing about.

There was a consciousness on the part of the British dramatist, during the '90s and thereafter, that the official censor was handicapping the stage in its efforts to keep abreast of the advancing times. The plays that were refused a license were of such a forward character as to make them notable targets for the King's Reader of Plays. Maeterlinck's *Monna Vanna* and Shaw's *Mrs. Warren's Profession* were refused production permits. There were also Shelley's *Cenci*, Ibsen's *Ghosts*, Brieux' *Maternité* and *Les Trois Filles de M. Dupont*, and Granville-Barker's *Waste*. Arnold Bennett, in his testimony against censorship before a parliamentary committee (consult Palmer's *The Censor and the Theatres*), declared: "Most decidedly the existence of the censorship makes it impossible for me even to think of writing plays on the same plane of realism and thoroughness as my novels." All the more reason was there to have channels of independent action, so as to cheat the censor. And the stage societies furnished these channels. See CENSORSHIP.

In all this era of "independent" theaters and "repertory" experiments, the preeminent British dramatists were Shaw, Galsworthy and Barrie: the first a social cynic with quick wit and profound insight into modern social conditions; the second a gentle humanitarian with a passionate dream of social justice; and the third a quaint sentimentalist and romanticist who came as a relief from the intellectual realism of what was soon known as the Manchester school of realism.

GEORGE BERNARD SHAW (1856-) has dominated the 20th century British theater. As dramatic critic, novelist, playwright, and a prime force with Sidney Webb in the Fabian movement, he has been an invigorating figure. Conservative England has fought over him as they fought over Ibsen. Shaw's ideas have been so prolific as to break through formal requirements of drama, and they have spread into a series of brilliant prefaces attached to each play. The variety of his themes has always been dominated by the individualism of his social philosophy. The latter is clearly defined in *Widowers' Houses*, 1892, *Can-*

dida, 1897, and *Mrs. Warren's Profession*, 1902. His handling of history is graphic and vigorous in *Arms and the Man*, 1894, *The Man of Destiny*, 1897, *Caesar and Cleopatra*, 1906 and *Saint Joan*, 1923. His ideas on creative evolution have expanded in *Man and Superman*, 1903, and *Back to Methuselah*, 1921. This will of intellect suggests the vigor of the Shavian mind as it has disported itself among contemporary themes and has reread history for one's delectation. And over everything he writes, there shines the brilliancy of his wit and the ease of his phrase.

The supreme excellence of JOHN GALSWORTHY (1867-) is as a novelist, his *Forsyte Saga* being a notable picture of a cross-section of English life during several generations. Like Hugh Walpole, he shows sympathy for the excellences of a social manner that is fast disappearing under modern conditions. His pronounced realism has always been tempered by a certain romantic love for humanity; but his observation is detailed and his hand is never unsteadied by sentimental concessions. His most distinguished plays, such as *The Silver Box*, 1906, *Strife*, 1909, and *Justice*, 1910, are marked by an almost judicial attitude toward social standards. His most effective stage piece, *Loyalties*, 1922, has a dominant dramatic quality which is of the theater rather than of literature. In all his plays he exhibits a passion to be fair. His *Old English*, 1926, is supreme portraiture for character acting. His irony is not bitter but kind. He is always the man of pity in the theater.

J. M. BARRIE (1860-) is the Peter Pan of the British drama. He established an individual flavor, native Scotch, in a series of novels filled with quaint character and much folk humor and tragedy. His plays carried this stamp further into unmistakable mannerisms. His craftsmanship is well calculated. Once or twice he has struck out into excellent imaginative realism in the theater. *Peter Pan*, 1904, is the child dream play of the century, sharing honors with Maeterlinck's *The Blue Bird*. His most serious dramas, such as *The Admirable Crichton*, 1903, *What Every Woman Knows*, 1908, and *The Twelve Pound Look*, 1910, are based upon "Barrie conceits"; and even such pieces as *Dear Brutus*, 1917, and *Mary Rose*, 1920, steep philosophy in sentiment of the Barrie sort. Barrie is the British dramatist who has never grown up.

The World War merely arrested the progress of the British theater; it did not change its current nor did it alter the course of the old stream. Ancient problems were again resurrected, like the establishment of repertory and of a national theater, and the dramatists went back to the perfecting of old forms. Now and again one heard war reactions against the old-time standards of patriotism, in such an apt play as *Wings Over Europe*, 1929, by Maurice Browne and Robert Nicoll. With a sincere directness which was the English counterpart of Remarque's *All Quiet on the Western Front*, came R. C. Sherriff's *Journey's End*, 1929, while the nervous aftermath of the struggle was vigorously felt in Clemence Dane's *A Bill of Di-*

vorcement, 1921. It may be that, as the drama has always done since the beginning of drama times, the British theater of post-war days followed contemporary widespread interest. Certainly death played an important part in the thinking of the British people after the war, and the acceptance of Sir Oliver Lodge's pronouncements, representing to the popular mind the general attitude of science toward spiritualism, may be laid to this mental receptivity. Sutton Vane's *Outward Bound*, 1923, struck a sympathetic, if not an entirely new note. And later, with the quandary of the popular mind over the theories of relativity, J. L. Balderston, an American familiar with British ways, created *Berkeley Square*, 1929, from one of Henry James's stories.

The sparkling impertinences of Noel Coward indicated that England's younger generation was rebelling against old conditions. But the English mind was concerned with changing social balances—not quite convinced whether or not they should be changed. The English novelist became critical, but still, looking backward, found the old-time institutions and barriers not quite so bad. Strachey's *Queen Victoria and Eminent Victorians* were avidly read. That interest may have prompted such a play as Rudolf Besier's *The Barretts of Wimpole Street*, 1930.

But in all of this interest there was nothing revolutionary, nothing out of the ordinary. Even as regards other countries, the English theater does not appear to have been seriously upset by the extreme theories of the Russians and the Germans. Chékov's plays surprised them, because it is not in the English theater nature to be frankly open and naively wondering about life. Virginia Woolf's discerning critical comments on the visit of the Moscow Art Theatre to London in 1920 are suggestive of the limitations of English character. Only Ashley Dukes, author of an imitative Restoration piece entitled *The Man With a Load of Mischief*, 1925, seems to champion the European dramatists. He stands in relation to these in the same position that Huntley Carter stood about 1914 in relation to Reinhardt, Diaghileff, Stanislavsky and Appia, when the names of these reformers were first being heard in the British theater through Gordon Craig. Ashley Dukes has loyally translated and commented upon dramas by Georg Kaiser and Ernst Toller, while the London dramatic critics have looked askance at their expressionistic form and their social displeasures.

It is not likely that any of the plays by JOHN DRINKWATER, A. A. Milne or St. John Ervine will serve to upset government or instill incendiary moods. The fact is, one might almost say that the English dramatic mind has preferred to look backward rather than toward the future, has preferred to take refuge in the past in order to interpret the present, or to state a philosophy by which to live in the present. Note that after the war Drinkwater wrote *Mary Stuart*, 1921, *Oliver Cromwell*, 1921, and *Robert E. Lee*, 1923; that Clifford Bax (1886-) preferred *Socrates*, 1930, and *Shakespeare*, 1921, the latter written

with H. F. Rubinstein, to something more concrete or something at least contemporary. The same can be said of Laurence Housman (1865-), Gordon Bottomley (1874-), James Elroy Flecker (1884-1925) and other poets of England. Gaining a distinctive poet laureate in JOHN MASEFIELD, the English have thereby seemingly lost to the British stage a distinctive dramatist.

All that can be said, therefore, for the British theater at the present is that such dramatists as John Van Druten, with *Young Woodley*, 1916, Frederick Lonsdale, with *The Last of Mrs. Cheyney*, 1925, St. John Ervine with *The First Mrs. Fraser*, 1929, A. A. Milne, with *Mr. Pim Passes By*, 1920, and *The Truth About Blayds*, 1921, are writing well, and that the old theater tradition is being fitfully maintained.

The independent theater movement has found its counterpart in late years, however, in local movements for the better dissemination of drama through the empire—not so completely dependent on the patronage of London as heretofore, and not so endangered by the American theater invasion of London. It is a movement similar to the American development of LITTLE THEATERS, semi-professional community houses and the attempt to place drama in the schemes for adult education. The London Board of Education issued in 1926 a report on the subject (Paper No. 6), showing how thoroughly and how self-consciously they are planning to make theatergoers intelligently aware of the best there is in drama of all countries. Coincident with this, as in America, there is also a self-conscious approach of local tradition for folk drama, so that now one finds special studies on the Manchester dramatists, the drama of Gloucestershire, Yorkshire plays, and peasant drama, typified by the work of Eden Phillpotts.

If the English drama, therefore, has not advanced much within recent years, it is due largely to the conservativeness of the British mind toward morals, government and international relations, to the fact that she is still insular. She has remained unruffled in the theater by German expressionism, and unshaken by Russian constructivism. Conservatism has thus far kept the British drama from any violent experimentation.

M. J. M.

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ENGLISH LANGUAGE, a very important member of the western branch of the Germanic division of the INDO-EUROPEAN linguistic family, sometimes classed together with FRISIAN, its nearest cognate, as the "Ingvaconic sub-group." It is divided into three periods: Old English, or Anglo-Saxon, from the latter part of the 7th century to about 1100; Middle English, from about 1100 to the end of the 15th century; and Modern English, from the 16th century onward.

Carried to Britain by the Teutonic Angles, Jutes, and Saxons, who began to invade the island in the middle of the 5th century A.D., its first records are dated two centuries later. Old English had four main dialects: Northumbrian, spoken, as its name implies, north of the Humber; Mercian, between the Humber and the Thames; West Saxon, south of the Thames, except in Kent, part of Surrey, and the Isle of Wight; and Kentish, in the southeast. Northumbrian and Mercian, derived from the dialect of the Angles, are frequently grouped together as Anglian; Saxon represented the language of the Saxon invaders, and Kentish, that of the Jutes.

The earliest extant literature is Anglian, as in Caedmon's paraphrases of the Bible, *Béowulf*, and the poems ascribed to Cynewulf, etc. In the 9th century, however, with the increasing importance of the kingdom of Wessex, its dialect, West Saxon, rose to dominance, due largely to the influence of EGBERT and ALFRED THE GREAT. A notable literary revival was the result, as shown by the early part of the *Anglo-Saxon Chronicle*, as well as by translations of works of Gregory the Great, Orosius, Boethius, Bede and others; and though this movement itself waned, Anglo-Saxon literature attained its acme under Ælfric.

In structure, Old English was typically Teutonic. The nouns and adjectives were divided into "strong" and "weak," the latter distinguished by *n* in all cases but the nominative singular, e.g., *hús, húses*, "house," but *góma, góman*, "man"; and they, like the pronouns, had five cases—nominative, genitive, dative and accusative, with traces of the instrumental, the latter still surviving in the type of *the* in *the more, the merrier*. The verb had two tenses, present and past, the latter a survival of the Indo-European perfect; and was likewise either "strong" or "weak," the former (with several divisions) characterized by VOCALIC ALTERNATION as still seen in the type, *sing, sang, sung*, and the latter by a past tense in *d* of somewhat problematical origin, still retained in *love, loved; lose, lost*. The vocabulary was in the main Germanic, with comparatively few borrowings from Latin, Danish, Celtic, or Northern French.

By the time of the Norman Conquest, the inflectional system showed marked signs of decay, and Old English was already passing into the Middle English stage. Such was the vitality of this new phase that, despite the Conquest, it continued to be the vernacular of the great body of the people, Norman French serving as the language of Parliament, the courts and the upper classes until the conquerors were gradually absorbed by the conquered. The chief contribution of the Normans to English was in vocabulary; but comparatively few works, none of them outstanding, were written in it for a century or more after the Conquest. In the north of England and to a somewhat less degree in the Midlands, inflections became fewer and fewer, the case-endings of the nouns, adjectives and pronouns being replaced by prepositions, and the personal endings of the verbs

by pronouns. The written language, however, in keeping with the universal tendency of literary dialects, evolved more slowly than the vernacular, retaining many forms that were fast becoming obsolete in everyday speech.

The dialects of Old English continued to be distinct, and their differences were even intensified. When English again became a truly literary language, having completely displaced the speech of the conquerors, there were well-defined Northern, Midland and Southern dialects, the second subdivided into East and West Midland. All these had their own literary exponents, but gradually the Midland dialect gained ascendancy. London and the great universities were in the Midlands; CHAUCER, Gower and Langland wrote in Midland, and their works helped establish it as the national language.

By 1500 Modern English had more or less developed, its progressive loss of inflection, which still tends to continue, having made it more "analytical" than any other modern European language. It is essentially a direct evolution of the Eastern Midland form of Middle English, although it preserves many traces of the other Middle English dialects. The art of printing was a potent factor in standardizing usage and in welding a consistent and homogeneous language from the various dialects; and the process was furthered by the rapid growth of literature which began in the Renaissance, especially by such works as the Bibles of Tyndale and King James, and by the later flood of grammars, rhetorics and dictionaries, culminating in *The New English Dictionary*.

The vocabulary of English has been enormously enlarged since 1500. Through the revival of learning many Greek and Latin words found their way into it in addition to the Latin, Celtic and French words which it already contained; and later there was a heavy borrowing from ROMANCE. To such an extent was this carried that a tendency to Latinize and Gallicize English was later bitterly opposed by those who sought to keep the language as "pure," i.e., as Teutonic, as possible, the two classes of extremists serving to counterbalance each other. In more recent years even the languages of the Orient and of the remoter parts of Europe have made their contributions; but for the last two centuries, increasing discrimination has been shown in the adoption of foreign words and idioms. As a result of these borrowings, few languages have the literary potentialities of English, where the wealth of synonyms renders it possible to make so many delicate distinctions in meaning.

Despite the general tendency toward standardization, certain dialectic differences in usage, vocabulary and pronunciation still persist in Britain as well as between British and American English, the latter being itself not without dialectic peculiarities. Certain words now used in American English retain meanings lost in Britain, just as it is well known that Irish "brogue" is in reality an archaic pronunciation of Modern English. British dialects, moreover, preserve many old words and pronunciations lost in the

standard speech, and are indispensable for any complete knowledge of English, especially as they preserve many of the peculiarities of the older forms of speech from which they developed. A recent classification of them retains the Middle English grouping into Northern, Midland and Southern, the widely spread Midland dialects being further divided into Western, Midland and Eastern. To these must be added the English dialects of Ireland and Scotland, the latter distinctly Northern in source. In the United States themselves the development of new dialectic differences may be observed, and there appears to be a tendency for these differences to increase notwithstanding all the influences that make for complete uniformity.

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ENGLISH LAW. England was the only country in the modern world to develop a matured system of law independently of the Roman law. The history of English law as a system begins substantially in the thirteenth century with the establishment of the King's courts as they continued to be in substance down to the nineteenth century. English law is chiefly the work of these courts through experience of judicial decision and practice of applying reported judicial experience to the decision of cases. When the English colonization of America began in the seventeenth century, the system of English law was well developed, and American law is a working over through American courts of English law as it stood in the seventeenth and eighteenth centuries.

ENGLISH LITERATURE. The English language has a continuous history, notwithstanding changes in its inflectional system, syntax and vocabulary, from the Germanic dialects spoken by the Angles and Saxons, through the stages known as Middle English, 1100-1500, to the standard speech of the present day. English literature, on the contrary, has no such consecutive development. It falls into two disconnected parts, separated historically by the Norman Conquest and the three centuries during which French was the official language of England. Between the writings of the Anglo-Saxons and the truly national literature born in the age of Chaucer there exist the same kind of linguistic differences that distinguish classical Latin literature from the Romance literatures of France or Italy. In addition, while the classical tradition was never entirely broken, the surviving fragments of Anglo-Saxon writing were completely lost to memory until discovered by scholars after the lapse of centuries. If one commences a historical survey of English literature by reviewing the earliest texts written in England, it is only as one might before reading an old play examine a prologue written for a different occasion by a distant cousin

of the dramatist and through the family pride of an editor included in the same volume.

Anglo-Saxon. Two productive periods are distinguishable in Anglo-Saxon literature, one dating from the early 8th century in Northumbria, the other occurring toward the end of the 9th century in Wessex. With the first are associated the scholars, Bede and Alcuin, the unknown poet of *Beowulf*, and two writers of Christian epics, Caedmon and Cynewulf. The second era, that of King Alfred, was concerned mainly with the translation of historical and religious books and the collection of chronicles.

The pagan past, as filtered through the mind of a clerical scribe, is best represented in the epic of *Beowulf*, the work of a conscious though naïve artist who has successfully combined a Scandinavian subject with English feeling, supernatural exploits with authentic history, pagan violence with Christian morality, and has fused these disparate materials in the sustained noble gravity of his style. Written in the traditional four-stress, alliterative verse, *Beowulf* sounds the whole gamut of Anglo-Saxon poetry. The other principal poems may be described as developing one or more of its attributes: *Widsith*, its fondness for naming famous peoples and princes; the *Finnesburgh* and *Waldere* fragments and the later war songs of *Brunanburh* and *Maldon*, its mood of grim determination; *Deor's Lament* and lyrics, its diffused melancholy; the *Riddles*, its favorite rhetorical device of periphrasis; the Biblical narratives and saints' lives, its scope, consciousness of heroic etiquette, and Christian ethics.

The Christian past is the subject of Bede's *Ecclesiastical History of the Angles*, a well-documented work which still retains its authority. Though written in Latin, it is instinct with racial feeling and reveals more clearly than many hundred lines of religious verse the spirit of Northumbrian monastic culture. At times, too, as in the comparison of man's life to a sparrow flying through a hall, or in the story of how Caedmon became a gleeman of God, Bede's simple prose rises to poetic heights unsurpassed by anything in the vernacular.

Second only to Bede's work as a historical document is the *Anglo-Saxon Chronicle* compiled in various monasteries at the bidding of King Alfred. The prose translations written by the king himself are of small literary importance.

Writing in English ceased for a century following the Norman Conquest. When resumed it first consisted of a thin stream of homiletic compositions, but under French influence soon widened to include verse romances, poetic debates, rhymed tales, folksongs and political verse. Laurence Minot used a rugged English to celebrate Edward III's victories; 50 years later, however, Gower still hesitated to employ the native tongue.

His hesitation was justifiable. Before 1350 the best current literature in England was composed of French verse-chronicles and both serious histories and courtier's trifles written in Latin. In his Latin *History*

of the Britons, c. 1147, of dubious authenticity, Geoffrey of Monmouth magnified the story of King Arthur, which was retold in French verse by Gaimar and Wace, given an English dress in Layamon's *Brut*, c. 1200, and meanwhile supplemented by the sentimental *Lais* of Marie de France and the Grail romances attributed to Walter Map.

English prose, as formerly, was used chiefly in translations, notably in the *Travels of Sir John Mandeville*, 1377. No more original writer of prose can be named than JOHN WYCLIFFE, controversial preacher and pioneer translator of the Bible.

Fourteenth Century Poetry. English poetry leaped to maturity shortly after 1350, both in London and in the provinces. The old fashion of alliterative verse was revived in several Arthurian romances, particularly in the charming tale of *Sir Gawayn and the Grene Knight*, c. 1360, by an unidentified author who probably also wrote the touching mystical vision called *Pearl*. It was likewise the vehicle of a huge satire, the *Vision concerning Piers Plowman*, attributed to WILLIAM LANGLAND. In its original form (1362), an allegorical picture of the confusion of the times and a plea for the restoration of social order, the poem was twice revised and expanded, possibly by several hands. Its fame is due less to its graphic scenes than to its attacks on the clergy. The *Bruce*, 1378, of John Barbour marks the beginning of patriotic Scotch poetry.

In language, form, or outlook all these poems were bound to the past, and the same was true of the Latin *Vox Clamantis* and the English but scholastic *Confessio Amantis* of John Gower.

Chaucer. The way to the future was opened by GEOFFREY CHAUCER (1340?-1400) who, writing in the "King's English" of London, polished the language until it became capable of subtle expression, established the iambic pentameter as the normal line of English verse, naturalized in English poetic material borrowed from France and Italy, and in the lucid mirror of his maturest work reflected the whole social life of his century.

Although Chaucer's career as page, squire, diplomat and official brought him in touch with all classes of people, the world of books remained for him a region apart. He served his literary apprenticeship by translating the *Roman de la Rose* and imitating the elaborate fixed forms of French verse. His earliest important poem, the *Boke of the Duchesses*, 1369, owed much to the medieval type of dream-allegory, as did also the *Parlement of Foules* and the *Hous of Fame*, but each contained characteristic touches of shy realism. A diplomatic mission in 1372 introduced him to the new poetry of Italy, and from two erotic verse-romances by GIOVANNI BOCCACCIO he drew the outlines and many details of his *Knightes Tale* and *Troilus and Criseyde*, in each instance freely adapting his material. About 1385 he abandoned the slight collection of stories called the *Legend of Good Women* to work at the longer project of the *Canterbury Tales*. He lived to write only the *Prologue* and a score of tales, two of them in prose.

Troilus and Criseyde is Chaucer's longest individual poem and one of his great achievements. Its stilted love story is redeemed by a curious penetration into the springs of action which makes the poem essentially a psychological novel, the first of its kind in English. In the *Canterbury Tales* his treatment of character is freer, broader and more various. While many of the separate tales are little masterpieces of narrative, the distinction of the whole lies in its portraiture of the 30 pilgrims and the dramatic interplay of their personalities. His art is best seen in the general *Prologue* and the remarkable confessions of the Pardoner and the Wife of Bath. Over all his writing is an air of freshness, humorous understanding and the joy in life that makes Chaucer the most companionable of poets.

Early 16th Century. After Chaucer's death poetry was continued by a succession of mediocre versifiers, Occleve, Lydgate and Hawes, whose whole vocation was endless imitation, and by the more capable Scotch Chaucerians, King James I, Robert Henryson, William Dunbar and Gavin Douglas, in whose work both the delicate allegory and the coarse realism of the *Roman de la Rose* found a last local habitation. Variety but little distinction appeared in the *Ship of Fools*, 1509, translated from the German by Alexander Barclay, and in the jilting satires of JOHN SKELTON (1460?-1529). To the 15th century may also be assigned some popular ballads, notably *Chevy-Chase* and the vigorous Robin Hood series; the perfected MIRACLE PLAYS performed by artisans' guilds at Easter, Christmas, or Corpus Christi; and the earliest MORALITIES, of which *Everyman*, c. 1495, is a favorable specimen. In the prose *Morte d' Arthur*, 1484, of SIR THOMAS MALORY, published by England's first printer, William Caxton, the legend of Britain attained its standard form in English and the age of chivalry its Indian summer.

The Renaissance. During the Renaissance period, 1525-1660, an intensified national consciousness and a robust individualism replaced the Catholic discipline of the Middle Ages. Then occurred the revival of classical learning, the reformation of the English Church, the beginning of the British Empire overseas, the formulation of the principles of experimental science and the downfall of absolute monarchy; meanwhile the hope and glory of the time were reflected in an unmatched outburst of literature.

The New Learning stimulated a spirit of inquiry which effectually challenged the dogmas of medieval belief. A typical product of early Humanism was Sir Thomas More's *Utopia*, 1516, in part a free speculation on the nature of an ideal society, in part a satire on existing abuses, written with a daring open-mindedness anxiously at odds with the author's real conservatism. A revolutionary advance in thought was started by the *Novum Organum*, 1620, of FRANCIS BACON, which, in developing the view that "man is no more than the servant and interpreter of Nature," made possible an alliance between the rational mind and the physical senses, now first reduced to

order under the laws of scientific measurement. Bacon's epoch-making work, like More's *Utopia*, was written in Latin. As an English prose-writer he is famous for his brilliant and pithy *Essays*, 1598-1625, the earliest English examples of their kind.

Familiarity with Greek and Latin classics also bred a respect for standards that reinforced the innate traditionalism of English minds. Humanism appeared as a stabilizing force in Roger Ascham's educational tracts: *Toxophilus*, 1545; *Scholemaster*, 1570; in Sidney's literary criticism: *Defence of Poesie*, 1595, and in Richard Hooker's defense of the Anglican middle way against the assaults of Puritan extremists: *Ecclesiastical Polity*, 1593.

Both ancient and modern authors were freely translated, the most notable achievements in this kind being Chapman's Homer, North's Plutarch, Hoby's *Courtier*, and Florio's *Montaigne*.

The English Bible also received its final perfecting at this time. The translation by William Tindale and Miles Coverdale, 1525-35, laid the foundation for the Authorized Version of 1611, undertaken at the instance of James I by a committee of 40 divines headed by Bishop Lancelot Andrews. No other work has exercised a more powerful formative influence on English national feeling and habits of expression.

Prose fiction, besides much plundering of Italian *novelle*, included two original romances: *Euphues*, 1578, by JOHN LYLY and *Arcadia*, 1590, by Sidney, which encouraged a temporary fashion of artificial writing. More natural pictures of Elizabethan life were given in the homely novels of Deloney and the realistic pamphlets of Greene, Nashe and Dekker.

The prose epic of English commerce, Richard Hakluyt's *Principal Navigations*, reached its final proportions in 1598. Among miscellaneous and sometimes eccentric prose works of the succeeding 60 years should be mentioned Robert Burton's *Anatomy of Melancholy*, 1621, Sir Thomas Browne's *Religio Medici*, 1645, and *Hydriotaphia*, 1658, Jeremy Taylor's *Holy Living*, 1650, Izaak Walton's *Compleat Angler*, 1653, and Thomas Fuller's *Worthies*, 1661. These books, like Milton's *Areopagitica*, 1644, and his tracts on liberty, are marked by a poetized, Latinistic style which has its mighty cadences but rarely the virtue of simplicity.

Poetry made small progress during three-quarters of the 16th century. Little need be noted except the introduction of Italian forms including the sonnet by SIR THOMAS WYATT (1503-42) and the EARL OF SURREY (1517-47), the first use of blank verse in Surrey's translations from the *Aeneid*, a reversion to medieval tradition in Thomas Sackville's contributions to the *Mirror for Magistrates*, 1573, and a variety of experiments by the pedestrian but fluent George Gascoigne.

The ardent, idealizing lyrics of the courtier-poet, SIR PHILIP SIDNEY (1554-86), sounded a new note. His *Astrophel and Stella*, written about 1578, was the precursor of the Elizabethan sonnet-sequences

modeled on Petrarch, and with Spenser's *Amoretti* and Shakespeare's *Sonnets* it remains the most brilliantly individual example of a conventional type.

Sidney's untimely death left to EDMUND SPENSER (1552-99) the task of endowing English poetry with the gorgeous colors of Italian painting, the symbolic movement of masque and pageantry and the intricate harmonies of music. The virtuosity of Spenser's *Shepherd's Calendar*, 1579, which announced his poetic coming of age, was elaborated in his platonic *Hymns to Love and Beauty*, in pastoral elegies and satires contrasting a Golden Age of his imagining with sordid actuality, and in his decorative triumphs, *Epithalamion* and *Prothalamion*. His half-completed *Faerie Queene*, 1590-96, best reveals his marvelous gift as a plastic artist using the medium of words. Knights, damsels, enchanters and monsters drawn from antique chivalry; a high-souled English and Protestant patriotism; a moral purpose "to fashion a gentleman or noble person in virtuous and gentle discipline"; a consciously archaic diction, echoing Chaucer; and the cunningly prolonged cadences of the Spenserian stanza: these were less elements fused by strong feeling than colors on the poet-painter's palette. Both author and reader soon weary of the allegories and are content that the poem should lose itself in dream-pictures of adventure. A characteristic Renaissance romantic epic in its wealth of sensuous delights, the *Faerie Queene* has remained a school for many succeeding poets.

Among the lesser glories of Elizabethan poetry may be cited a group of glowing, erotic narratives typified by Marlowe's *Hero and Leander* and Shakespeare's *Venus and Adonis*; the patriotic, leviathan verse-chronicles of Samuel Daniel and Michael Drayton; the religious allegories of Giles and Phineas Fletcher; the "regular" satires of Hall, Marston and Donne; the eclogues of George Wither and William Browne; and the exquisite lyrics of Peele, Shakespeare, Jonson, Beaumont and Fletcher, and Dekker among dramatists, and of Thomas Campion among song-book writers.

The two poets preeminent for their influence on seventeenth-century lyrists were BEN JONSON and JOHN DONNE. To the "Tribe of Ben" belonged the polished amorist, Thomas Carew, the Cavalier poets, Sir John Suckling and Richard Lovelace, whose verses with occasional rare felicity rang the changes on the themes of loyalty and love, and the delightful ROBERT HERRICK, whose *Hesperides*, 1648, is the nearest English equivalent to the *Greek Anthology*. The surprising intellectual "conceits" of Donne's close-packed poems were turned to religious uses by the "metaphysical" poets, George Herbert, Richard Crashaw and Henry Vaughan.

The Puritan ANDREW MARVELL (1621-78) has affinities with both the foregoing groups, but the prevailing note in his poetry is an unaffected love for the English countryside and the charms of Nature. He early composed "metaphysical" love poems and a sturdy *Horatian Ode* to Cromwell, but after

the Restoration wrote only satire. Had he given more attention to the smoothness of his lines he might be grouped with the precursors of the classical movement, Abraham Cowley, Edmund Waller and John Denham who, in copying the restraint and elegance of the ancients, prepared the way for Dryden and Pope.

Drama, destined to become the dominant form of Renaissance literature in England, was widely diversified before 1578. Current types included the surviving miracle plays, moralities tinged with educational or religious propaganda, farcical interludes, academic imitations of classical comedies and tragedies, and translations of Spanish and Italian plays. Udall's rhymed comedy, *Ralph Roister Doister*, c. 1533, and the Senecan tragedy, *Gorboduc*, 1562, written in blank verse by Sackville and Norton, gave early indications of a formal reliance on classical models, while the native epic drama was continued in crude dramatizations of history or romance such as Bale's *King Johan*, c. 1548, and Preston's *Cambyses*, 1569.

Professional companies of actors were formed as early as 1550 and soon regularized their position by securing the protection of powerful noblemen. The first public theater built "in the fields" outside London in 1576 was copied by other playhouses "on the bankside" just across London Bridge.

During the 1580's the repertory of the popular theaters was greatly improved by a group of young playwrights tintured with university learning and emulous of court refinement. Though their plays are sufficiently various, each writer may be credited with an individual contribution to dramatic resources: John Lyly, the witty dialogue of his prose comedies; George Peele, a gracefully decorative poetic fancy; Robert Greene, a vein of tender idyllic romance; Thomas Kyd, the concentrated intensity of his revenge-plays; and CHRISTOPHER MARLOWE, scenes of extravagant passion and the tremendous declamation of his blank verse. The anonymous crime-play, *Arden of Feversham*, 1586, should also be recognized for its powerful character-drawing.

Shakespeare. These several gifts were combined and enhanced in the plays of WILLIAM SHAKESPEARE (1564-1616), a professional actor who began to retouch old plays and improvise new ones soon after Kyd and Marlowe had achieved renown. From the start this new playwright showed an amazing power to surpass his rivals in their own specialties. While staging improved versions of the revenge-play, *Titus Andronicus*, and the three parts of the chronicle-history, *Henry VI*, he outdid Lyly in *Love's Labour's Lost*, Greene in *Two Gentlemen of Verona* and Peele in *A Midsummer Night's Dream*, besides cleverly adapting a Plautian comedy to popular taste. Well might Greene denounce the trespasser as "an upstart crow beautified with our feathers."

Shakespeare did not waste his strength on innovation. Except in four of his lightest comedies his plots were borrowed, often from previous plays. He

accepted the conventions of the theater as he found them, and succeeded in transforming such liabilities as the clown into dramatic assets. Even the changes in the tone of his writing may better be explained by revolutions in literary fashions than by any known events of his life. Between 1592 and 1601, with the sole exception of *Romeo and Juliet*, he wrote nothing but epic dramas on English history and light-hearted comedies, the two most popular genres of the time. A revival of the vogue of somber tragedies preceded the production of *Hamlet*, *Othello*, *Lear* and *Macbeth*, the Roman tragedies, and the "dark comedies," 1601-08. In like manner the novel plays of Beaumont and Fletcher probably led to the dramatic romances of Shakespeare's final period, 1608-16.

Versatility and a genius for assimilation help to explain Shakespeare's immediate success, but his universal fame rests on other grounds. Among the dramatists of his time he alone possessed a sure perception of imaginative truth. In consequence of his solid habit of interpreting both history and romance by the life of his own day, his characters from Puck to Falstaff and from Dogberry to Hamlet are convincingly alive. Though careless of inessentials and lacking restraint, he was able to offset his slips and excesses by an unfailing sanity of judgment, the abundance and felicity of his command of words and the limpid inclusiveness of his understanding. It was not his object to preach a single philosophy, but rather to illuminate the working of men's hearts as if by interior daylight. Trained by the exigencies of the popular stage, he attained instinctive mastery of a dramatic art not less valid than that of the Greeks and so infinitely various that his plays seem to comprehend human nature in a microcosm intelligible to all times and lands.

Shakespeare's Contemporaries. Shakespeare was not without worthy rivals. From 1598 onward his supremacy was challenged by other dramatists whose literary skill in many respects matched his own. Most prominent among his contemporaries were Ben Jonson, George Chapman, John Marston, Thomas Dekker, Thomas Heywood, Thomas Middleton, John Webster, Francis Beaumont and John Fletcher. With the somewhat later plays of Philip Massinger, John Ford and James Shirley the drama entered upon a Silver Age which terminated with the closing of the theaters in 1642. In the work of all these writers may be noted an increasing dexterity in dramatic technique accompanied by a loss of centrality, balance, and truth to nature. The labored "humour-comedy" of Ben Jonson, the elaborate realism of Dekker, the strained sentiment of Beaumont and Fletcher, and the histrionic sensationalism of Ford mark a decadence. Yet even in its ashes the drama glows with the fire of a great poetic age.

Milton. The last isolated figure of the Renaissance was JOHN MILTON (1608-74), whose mature work was written under the Restoration. After a handful of early poems, including *L'Allegro*, *Il Penseroso*, *Comus* and *Lycidas*, had proved his fine talent, he

gave himself unreservedly to Puritan politics and, except for occasional sonnets, abandoned poetry for 20 years. Then, in obscurity and blindness, he dictated his masterpiece, *Paradise Lost*, 1667; its sequel, *Paradise Regained*, and the poetic drama, *Samson Agonistes*, both of 1671. Neither the subdued but lovely idyll of Christ's triumph nor the touching spiritual autobiography symbolized in the tragedy of Samson's death equal the sweep and power of Milton's epic on the Fall of Man. *Paradise Lost* is the Christian counterpart of the *Aeneid* and the ultimate poetic treatment of human destiny. The dignity of its subject is sustained by its majestic blank verse, lofty diction and tremendous imagery. Yet Milton's learned artistry could not transcend the limitations of his moral vision. His attempt to invest the Protestant attitude with beauty, grandeur and universality breaks down at times under the weight of its own absurdity. A defective sense of human values has made his great poem an almost exclusively insular epic.

The Restoration. The year of the Restoration, 1660, may be taken to mark the division between an age of spiritual and poetic ardor and an age of sense and prose. The contrast is immediately apparent in Samuel Butler's *Hudibras*, 1663, a slap-stick mock-epic directed against the Puritan zealots, and John Bunyan's *Pilgrim's Progress*, 1678, 1684, which in a fervent prose allegory expressed the abiding religious hope of humble people. Changes in social life and manners within the sphere of court influence are amusingly reflected in the *Diary*, written 1660-69, of SAMUEL PEPYS and in the graver pages of JOHN EVELYN. The intellectual movement toward empirical rationalism may be studied in Hobbes's *Leviathan*, 1651, Newton's *Principia*, 1687, and Locke's *Essay Concerning Human Understanding*, 1690.

An immediate consequence of Charles II's return was the reopening of the theaters and the revival of national drama in an atmosphere charged with French influences. Between 1660 and 1670 rhymed "heroic tragedies" had their temporary vogue and provoked the ridicule of Buckingham's *Rehearsal*, 1671. Dryden in *All for Love*, 1678, and Otway in *Venice Preserved*, 1682, produced unrhymed tragedies that stand comparison with their Elizabethan models. Etherege, Wycherley, Dryden and Shadwell, followed by Congreve, Vanbrugh and Farquhar, carried the English comedy of manners to its highest perfection, as exemplified in Congreve's *Way of the World*, 1700. Under the Restoration, women first appeared as actors and playwrights, notably Mrs. Aphra Behn, who also wrote the exotic romance of *Oroonoko*, 1688.

Besides being a fertile dramatist, JOHN DRYDEN (1631-1700) became the leading poet and critic of the Restoration. The desire for balance and order is evident in his well-turned lyrics, such as the *Song for St. Cecilia's Day* and *Alexander's Feast*, and especially in the pointed and polished heroic couplets of his satirical and controversial pieces. As a conscious artist he discussed the rules of the new classicism in

prefaces and essays that constitute the first large monument of English literary criticism. His most important poems are the satires, *Absalom and Achitophel*, 1681, and *MacFlecknoe*, 1682, the didactic *Religio Laici*, 1682, and the *Hind and the Panther*, 1687, and the translations or adaptations of Latin poets, Chaucer and Boccaccio contained in *Fables*, 1700.

Eighteenth Century Poetry and Prose. Dryden's successors from 1700 to 1740 continued his work of establishing a rule of order in art and life. The foremost artisan of verse, ALEXANDER POPE (1688-1744), concentrated all his efforts on the problem of correct expression and succeeded in perfecting the heroic couplet as the special medium of satirical and didactic poetry. Fresh observation, strong feeling—except when his vanity was wounded—and even connected thinking were not within his scope, but his power to enhance commonplaces by glittering epigrammatic statement has never been rivaled. The most admired poem of the age was his translation of Homer. His *Essay on Criticism*, 1711, *Rape of the Lock*, 1712-14, *Dunciad*, 1728, *Essay on Man*, 1733, and various epistles and satires modeled on Horace are memorable less for their substance than for their unflinching brilliance and occasional malice. Wit and restraint also predominate in the work of Matthew Prior, a graceful parlor poet, and John Gay, author of the realistic *Trivia*, 1716, and the facetious *Beggar's Opera*, 1728.

The chief writer of classical prose was JONATHAN SWIFT (1667-1745), whose corrosive, tortured genius disciplined itself to lucid and forceful expression in religious and political controversy and destructive satire. A fierce partisan in the struggle of Whigs and Tories, a defender of the Anglican Church against Catholics and Deists, and a champion of the Irish people against British exploitation, Swift gave allegiance to causes and orthodoxies that his penetrating criticism of values had already undermined. In *Gulliver's Travels*, 1726, an ingenious allegory and a surface play of humor and irony mask the ultimate bitterness of a truth-loving mind insensitive to human sympathy.

The broadening down of literature to include middle-class readers led to the rise of journalism and periodical essays. In the latter kind SIR RICHARD STEELE and JOSEPH ADDISON, whose diverse temperaments are manifest in the contrast of Addison's frigidly rhetorical *Cato* and Steele's sentimental comedies, won preeminence by their collaboration in the *Tatler*, 1709-10, the *Spectator*, 1711-12, and several later publications. Tactfully combining the elegance of the patrician and the morality of the tradesman, the two authors promulgated a standard of social values that both coffee-house and tea-table readers approved. Throughout the century the *Spectator* remained a model of polite writing. In the lower walks of journalism and political pamphleteering DANIEL DEFOE did yeoman service, but his permanent reputation was made by the realistic romances of adventure that he wrote late in life, *Robinson Crusoe*, 1719, and

the lesser fictions of *Captain Singleton*, *Moll Flanders*, *Colonel Jacque*, etc.

The Classical movement, though originally spontaneous, soon became too rigidly formalized to respond to all the needs of the age. A note of repressed sentiment may therefore be discerned even at the moment of the Classical triumph. Premonitions of Romantic feeling increased during the 18th century and blended in various fashions with the prevailing modes. In poetry these divergent tendencies showed themselves most strikingly in the love of Nature and ardor of sensuous perception in James Thomson's *Seasons*, 1726-30; the romantic melancholy of Edward Young's *Night Thoughts*, 1741-45; the morbid lyrical sensibility of William Collins, *Odes*, 1747, and Thomas Gray's famous *Elegy*, 1750; the revival of the "Gothic" past in Macpherson's *Ossian*, 1760-63, Percy's *Reliques*, 1765, and Chatterton's Rowley poems, written 1765-70; the revelation of religious fervor, humanitarian sympathy and psychological intensity in William Cowper, author of *The Task*, 1785, etc.; and finally the realism for realism's sake of George Crabbe, who wrote *The Village*, 1783.

Prose fiction, less bound by tradition than poetry, was more free to exploit these unorthodox impulses. The novel of sentiment appeared with a strong infusion of bourgeois morality in Samuel Richardson's *Pamela*, 1740, the earliest example of a fully developed novel of any kind. (See SENTIMENTALISM.) Its popular pathos was intensified in *Clarissa Harlowe*, 1747-48, Richardson's masterpiece, and echoed in Goldsmith's *Vicar of Wakefield*, 1766. (See RICHARDSON, SAMUEL; GOLDSMITH, OLIVER.) Sentimentalism divorced from moral issues made up the whole stock in trade of eccentric Laurence Sterne's *Tristram Shandy*, 1760-67, and *Sentimental Journey*, while pure moral allegory in a vaguely exotic setting was represented by Samuel Johnson's *Rasselas*, 1759. The realistic novel, born when the virile and happy genius of HENRY FIELDING undertook to parody *Pamela* in *Joseph Andrews*, 1742, reached its culmination in his *Tom Jones*, 1749, and *Amelia*, 1751, and Tobias Smollett's picaresque *Peregrine Pickle*, 1751, and *Humphrey Clinker*, 1771. The "Gothic romance" or terror novel was begun half in jest by HORACE WALPOLE in *The Castle of Otranto*, 1764, but by the end of the century was being written in earnest by Mrs. Radcliffe, author of *The Mysteries of Udolpho*, 1794, and Matthew Gregory Lewis (*The Monk*, 1795). The most classical type of fiction, the novel of manners, came into being lastly in Fanny Burney's *Evelina*, 1778, and attained sure perfection in the hands of JANE AUSTEN, whose first "country-house comedies" were written before 1800 (*Sense and Sensibility*, 1811; *Pride and Prejudice*, 1813, etc.).

Johnson and His Circle. While Romantic tendencies were groping for expression in poetry and fiction, Classicism found a critical champion in SAMUEL JOHNSON (1709-84), a robust scholar and a pioneer in asserting the dignity and independence of letters. His *English Dictionary*, 1755, first established law and

order in the domain of language, while his edition of Shakespeare and his judicial *Lives of the Poets* attempted the same task in the field of literary criticism. Though a correct imitator of Pope in poetry and of Addison in the periodical essay, and a conscious supporter of classical tenets, Johnson ultimately obeyed the authority of experience as embodied in institutions and traditions and freshly interpreted by common sense. His vigorous empiricism preserved him from dryness. He is, however, less admired for what he wrote than for the singular force of his personality which, through the untiring efforts of his friend, JAMES BOSWELL, has been transmitted to posterity in the latter's *Life of Samuel Johnson*, 1791.

To Johnson's circle belonged the actor David Garrick and the painter Sir Joshua Reynolds, who each have their niche in literary annals; Oliver Goldsmith (1728-74), poet, essayist, novelist, and happy-go-lucky handy man of letters, who with RICHARD BRINSLEY SHERIDAN (1751-1816) was responsible for a brilliant revival of social comedy (Goldsmith's *She Stoops to Conquer*, 1773; Sheridan's *Rivals*, 1775, *School for Scandal*, 1777); and EDMUND BURKE (1729-97), defender of American liberties and founder of British Conservatism. The literary gossip of Johnson's day is amusingly reported in Horace Walpole's *Letters* and the *Diary* of Fanny Burney.

Eighteenth-century rationalism may be seen variously at work in the philosophical essays of David Hume; in Edward Gibbon's *Decline and Fall of the Roman Empire*, 1776-88; in Adam Smith's *Wealth of Nations*, 1776, which inaugurated the study of economics; and in Chesterfield's *Letters to his Son*, 1774, which formulated contemporary standards of polite behavior and the rules of worldly success. Touched by French Revolutionary fervor, rationalism gave rise to Thomas Paine's *Rights of Man*, 1791-92, and William Godwin's *Political Justice*, 1793.

The French Revolution also affected the two poets who stand as immediate precursors of the Romantic Movement, ROBERT BURNS (1759-96), and WILLIAM BLAKE (1757-1827). The Scotch peasant-poet saw in the rise to power of the Third Estate a confirmation of his innate sense of the dignity of man, while rebellion against artificial institutions lay at the heart of Blake's uncompromising scepticism. Burns was less original than Blake; his lyrics and idylls did not essentially change the substance of poetry but rather freshened its language and heightened its emotion. Blake's scarcely noticed poems, on the other hand, portrayed in a mythology of his own invention the intuitions of a childlike, candid mind seeking to comprehend a realm beyond the verge of consciousness where gigantic embodiments of Good and Evil peopled the darkness.

The Romantic Movement (see also ROMANTICISM) was in part a reaction against the outworn formulas of classical writing, in part a revival of the national past, and most of all a recreation of literature on the basis of a profounder understanding of human psychology. Implicit in the poetry of Blake, it became

conscious of its aims in the *Lyrical Ballads*, 1798, of Wordsworth and Coleridge. Unlike Classicism, however, it had no unifying convention; the Romantic writers were akin only in their reliance on the impulses of feeling and intuition.

WILLIAM WORDSWORTH (1770-1850) has the distinction of being the first great teacher of psychological truths by means of poetic suggestion. Using the simplest verse forms and a diction little removed from the language of ordinary speech, he managed to convey a sense of the rare moments of intense consciousness when the mind seems to see into the life of things and Nature appears radiant with spiritual energy. His natural pantheism is fully set forth in *The Prelude*, written 1798-1805, and *The Excursion*, 1814, and his better known short poems throw a glamour of unsuspected beauty over the commonest of natural objects and the humblest of human lives.

SAMUEL TAYLOR COLERIDGE (1772-1834) made his own the realm of the supernatural. *The Rime of the Ancient Mariner*, *Christabel* and *Kubla Khan* reveal his marvelous capacity to give a haunting reality to vague superstitions and insubstantial imaginings. In prose writings concerned with philosophy, criticism, religion and politics Coleridge was a sower of seminal truths and an early apostle of German idealism. His *Biographia Literaria*, 1817, and his lectures on Shakespeare and other poets disclose the unusual breadth of his outlook and the soundness of his critical method. The third of the "Lake poets," ROBERT SOUTHEY, is no longer celebrated for his mythological epics, but a few of his shorter poems survive; almost everyone knows his *Life of Nelson*, 1813. See also LAKE SCHOOL.

Unlike the three poets just mentioned, SIR WALTER SCOTT (1771-1832) never felt any enthusiasm for the French Revolution nor subsequent disillusionment. As an antiquarian and a painter of manners he reconstructed the local and national past, first in rattling narrative poems such as *The Lay of the Last Minstrel*, 1805, whose immense vogue has considerably waned, and later in the *Waverley Novels*, 1814-32, which entitle him to rank as one of the world's great writers of romance. In his life and in whatever came from his hand the simple manliness and generous ardor of Scott's character make his faults appear trivial.

The first generation of Romantic poets was either immune to the ferment of revolutionary ideas or reacted from them in the direction of health and conformity. The second generation grew up in an atmosphere of psychic revolt. In their brief literary careers Byron, Shelley and Keats reflected the unsatisfied aspirations of the period between Waterloo and the Reform Bill and carried their insurrection against convention to a point that isolated them from their contemporaries. Such lesser singers as Thomas Campbell, Samuel Rogers and Thomas Moore were at the time more widely approved than Byron and better known than Shelley and Keats.

GEORGE GORDON, LORD BYRON (1788-1824), first won attention by a Popean satire on reviewers, and became

famous on the publication of the first two cantos of *Childe Harold's Pilgrimage*, 1812, which were followed by Oriental tales in verse that superseded in popular favor the native verse-romances of Scott. After the failure of his marriage Byron lived abroad, chiefly in Italy, and died while taking an active part in the Greek war of independence. The last two cantos of *Childe Harold* and his later narrative poems and dramas sounded a note of moral revolt, emotional exhaustion and brooding despair that captured the imagination of Europe and made "Byronism" a synonym for the current *mal du siècle*. His most vigorous poem, *Don Juan*, 1819-24, is a mocking attack on social conventions whose power Byron had been made to feel, but which he was unable to respect.

From the present standpoint the potentialities of the Romantic mood seem to have been best realized in the poetry of PERCY BYSSHE SHELLEY (1792-1822) and JOHN KEATS (1795-1821). In the former a passionate intellectuality, attaching itself to forms of "atheism" and "anarchy," and a spiritual sincerity impatient of compromise were combined with a supreme lyric gift. From the doctrinaire pieces of his early youth he progressed steadily to the perfect fusion of thought, feeling and imagery of *Adonais*, *Epipsychidion* and his incomparable odes. In *The Cenci*, the one impressive tragedy of the period, Shelley constructed a powerful demonstration of the imperfection of human justice, and in *Prometheus Unbound* a lovely symbol of a world renovated by Reason and Love. The poetry of Keats, which appears dense and concrete beside the airy intensity of Shelley, embodies a subtle shifting of moral allegiance to a free indulgence of sensations. Unwavering in his pursuit of disturbing beauty, he moved rapidly from the morbid excess of *Endymion* through the luxurious charm of the *Eve of St. Agnes* to the restrained harmonies of *Hyperion* and his five great odes. His early death removed the poet whose work held most promise for the future.

Prose. The individuality released by Romanticism may be illustrated also in prose writers and critics who decisively broke from the formal model of the *Spectator* in favor of a more spontaneous, flexible and personal style. The finest artist and most winning figure among the essayists was CHARLES LAMB (1775-1834), in whose *Essays of Elia* a subjective and fanciful touch is balanced by a diffused and lively humor. Lamb, together with Leigh Hunt (1784-1859), WILLIAM HAZLITT (1778-1830) and Thomas De Quincey (1785-1859), did much to effect a revolution in critical taste which renewed the vogue of Chaucer, the Elizabethan dramatists and poets, and seventeenth-century prose writers, and popularized the work of the Lake poets.

Somewhat aside from the main current of Romanticism lie the important books of WALTER SAVAGE LANDOR (1775-1864), an exquisite stylist in verse and prose; THOMAS LOVE PEACOCK (1785-1866), the author of eccentric satirical novels; and William Cobbett (1762-1835), a sturdy political writer remembered for his sketches of English countryside in *Rural Rides*.

The Victorian Era. Between 1830 and 1870 the Romantic impulse waned and its expression became sporadic. The prevailing movement of the period was toward a new synthesis controlled by the spirit of positive science. Idealistic protests against the advance of intellectualism and materialism, however, were frequent. The writers of the Victorian age may be most significantly grouped in terms of their attitude toward the main mental effort of their time.

Among the forces of intellectualism in search of balance and order may be noted: the application of mathematical principles to social and moral phenomena by the utilitarians, Jeremy Bentham, David Ricardo and James Mill, and the refinement of their objective method by the Positivists, especially JOHN STUART MILL; the complete study of the facts relating to man in the past as exemplified in the historical works of Henry Hallam, T. B. MACAULAY, H. T. Buckle, J. A. Froude, E. A. Freeman, W. E. H. Lecky and others; the "Broad Church" movement and the introduction of "Higher Criticism" from Germany; the epoch-making scientific research of CHARLES ROBERT DARWIN (*Origin of Species*, 1859), the scientific propaganda of T. H. Huxley, and the exaltation of evolution into a universal philosophy by Herbert Spencer.

In fiction and poetry intellectual and scientific tendencies were reflected in an increased desire to portray the surfaces of life accurately and to analyze objectively the motives of action. WILLIAM MAKEPEACE THACKERAY (1812-63) hid his temperamental romanticism under the cynical airs of a London clubman in writing his minutely faithful pictures of the fringes of fashionable life, *Vanity Fair*, *The Newcomes* and *Pendennis*. GEORGE ELIOT (Mary Ann Evans, 1819-80) from the warm-hearted and sympathetic picturing of humble villagers in *Scenes of Clerical Life* and *Adam Bede* turned to the coldly intellectual analysis of moral problems in *Romola* and *Daniel Deronda*. A thoroughly realistic temper animated the minor novels of Anthony Trollope and the historical fiction of Charles Reade and others. The poetry of ROBERT BROWNING (1812-89) is like fiction in its careful probing of motives. A lifelong student of types of human energy drawn from the most diverse sources, Browning exemplifies in his dramatic lyrics, psychological monologues and poetic dramas the craving for analysis of man's inner nature which was a significant tendency of his time.

The writer who most definitely brought to a focus the various rays of Victorian intellectual culture was MATTHEW ARNOLD (1822-88). His elegiac, lucidly beautiful verse, like that of his friend Arthur Hugh Clough, represented a twilight of Romantic feeling consequent upon the attempt to reconcile high passion with clear thinking, but his critical prose heralded a new dawn in which the effort to "see life steadily and see it whole" was to be carried much further than Arnold himself cared to go. As an investigator of central principles in literature, social life and religion, however, he has remained a leading authority.

In direct contrast to Arnold and the positive think-

ers stands THOMAS CARLYLE (1795-1881), an intuitive idealist whose smoldering Hebraic nature radiated a confused but vehement doctrine of action, self-abnegation and reliance on forceful leadership (*Sartor Resartus*, 1833-34; *The French Revolution*, 1837, etc.). With him may be grouped the masters of a more supple prose, JOHN HENRY NEWMAN (1801-90), leader of the Oxford Movement of 1840, and JOHN RUSKIN (1819-1900), the aesthetic and social critic of Victorian civilization. These militant prophets pointed out the damage done to the soul of man by an era of positive science and industrial progress.

Their idealistic reaction found support in the humanitarian novels of CHARLES DICKENS (1812-70), who pleased a huge popular audience by his infectious gaiety and his grotesque sketches of lower middle-class characters, but stirred deeper currents of feeling by his indignation at injustice, cruelty and soul-debasing poverty. The fictional treatment of social problems was continued from various angles by Benjamin Disraeli, Mrs. Gaskell, and Charles Kingsley. Meanwhile Romantic sensibility was carried to an extreme pitch in the novels of Charlotte Brontë, who wrote *Jane Eyre*, 1847, etc., and her greater sister Emily, author of *Wuthering Heights*, 1847.

A similar prolongation of Romantic emotionalism is evident in the morbid dramatic poems of Thomas Lovell Beddoes, in the tender compassion of the *Song of the Shirt* and the *Bridge of Sighs* by the elsewhere sparkling Thomas Hood, in the mystical fervor of Christina Rossetti's lyrics, the domestic idylls of Coventry Patmore, and the "droppings of warm tears" of ELIZABETH BARRETT BROWNING. The "Pre-Raphaelite" poets, Dante Gabriel Rossetti and William Morris, brought to Victorian poetry the Italian suppleness and color of the former and the berserk vigor of the latter. (See PRE-RAPHAELITISM.) Rossetti's *House of Life* and Morris's *Sigurd the Volsung* opened in their several ways new horizons of the imagination. In ALFRED TENNYSON (1809-92) Romantic feeling was duly chastened by formal discipline and its intuitive certainties weakened into doubtful conformities. His golden, sometimes tinsel, lyrics, the *Princess*, *Maud* and *In Memoriam* show him struggling to capture intellectual substance worthy of his meticulous style; in *Idylls of the King* the effort was abandoned and Tennyson relapsed into a plangent singer of Victorian gentility.

After 1875 signs of reaction from the "Victorian compromise" multiply rapidly, but so complex are the cross-currents of literary tendency that no dominant trend can be discerned.

The cheery confidence of the early Victorians gave place to a bleak pessimism and somber despair adumbrated in the Oriental fatalism of Edward Fitzgerald's *Rubaiyat*, the fanciful symbols of James Thomson's *City of Dreadful Night*, and the grim realism of George Gissing's fiction, and concentrated in Thomas Hardy's later novels and poems, notably in the cosmic drama of *The Dynasts*. With vital humor and irony SAMUEL BUTLER in *Erewhon* and *The Way of All Flesh* took a mischievous delight in twitching away

the veils of Victorian conventionality, while the intellectual steel of GEORGE MEREDITH struck sparks of comedy from the flinty surfaces of a caste-bound society.

New forms of Romantic escape appeared in the sensual paganism of ALGERNON CHARLES SWINBURNE, author of *Poems and Ballads*, 1866, the luxurious mysticism of Francis Thompson and the native primitivism of Richard Jefferies. A morally healthy tincture of adventurous romance was prepared *virginibus puerisque* by ROBERT LOUIS STEVENSON. The cult of aesthetic intensity found a prophet in Walter Pater and an evangelist in Oscar Wilde, but reached exhaustion in the "decadent" poetry of John Davidson, Arthur Symonds and Ernest Dowson.

In Ireland a similar crusade for beauty was preserved from perversion by consciousness of the national past, hope for the national future, and closeness to the racy life of the common people. The Celtic Revival stimulated the poems and plays of WILLIAM BUTLER YEATS and "AE" (George William Russell), the peasant dramas of Lady Gregory and JOHN MILLINGTON SYNGE, and a large body of delicate lyrics by numerous writers. Somewhat outside the movement may be placed the novels of George Moore and the fantastic plays and tales of Lord Dunsany.

The 20th Century. The first quarter of the 20th century has seen literary parties disposed about as follows: on the conservative wing the supporters of traditionalism led by G. K. Chesterton and Hilaire Belloc and the imperialist cult of W. E. Henley and Rudyard Kipling; at the center a group of solid realists, of whom Arnold Bennett, Joseph Conrad, and John Galsworthy are representative, supported by writers of lucid critical prose, among whom Lytton Strachey is best known; toward the left the adventurous minds of Bernard Shaw and H. G. Wells, and at the extreme left D. H. Lawrence, James Joyce, and the "lunatic fringe." See also separate articles on these authors.

The most significant work of the present generation has been done in the novel, the drama and prose criticism. Poetry, even during its Georgian revival, has tended to become erudite and technical as in Robert Bridges, or esoteric as in the Imagists, or facilely popular as in Alfred Noyes and JOHN MASEFIELD, but the tradition of fine individual lyrics has been ably sustained by A. E. Housman, Walter de la Mare and W. H. Davies among others. The drama of Sir Arthur Pinero, Henry Arthur Jones, BERNARD SHAW, Sir James Barrie, JOHN GALSWORTHY, and the Irish playwrights has resumed its place in literature and stands beside the novel as an effective instrument for conveying these insights into reality on which recent literature most prides itself. G. F. W.

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ENGLISH SPARROW. See HOUSE SPARROW.

ENGRAVER-BEETLE, a small brown or black beetle of the family *Scolytidae*, called also the bark-beetle. These insects "engrave" burrows beneath the bark and in the sapwood of trees. When numerous, they may girdle the tree trunk. The adult female cuts an egg-tunnel in the inner bark or sapwood, laying eggs in egg-niches. Larvæ make lateral tunnels, which are often more or less parallel. Most species attack forest trees, and are very destructive to timber. Two species, the shot-hole borer and the peach-tree bark beetle, are well-known pests of fruit trees. The former is so called because of the tiny entrance holes of its burrows. It infests sickly trees.

ENGRAVING AND ETCHING. See REPRODUCTIVE ENGRAVING; AQUATINT; CHALK PLATE ENGRAVING; DRY-POINT; ETCHING; GLASS PRINTS; HELIOTYPE; INTAGLIO; LINOLEUM CUTS; LITHOGRAPHY; MANIÈRE CRIBLÉE; MEZZOTINT; PAINTER-ETCHER; PAINTER-LITHOGRAPHER; PHOTO-ENGRAVING; PHOTOGRAVURE AND ROTOGRAVURE; SOFT GROUND; STEEL-ENGRAVING; WOOD-ENGRAVING.

ENHAM, SIR JOHN (1615-68), British poet, was born at Dublin, Ireland, in 1615, and studied law at Lincoln's Inn. His tragedy, *Sophy*, was successfully produced in 1642; and his famous poem, *Cooper's Hill*, appeared the next year. He served Charles I, fled to France, and after the Restoration became surveyor of the royal buildings. Enham's later years were clouded by insanity. He died at London, Mar. 19, 1668.

ENID, a city in northwestern Oklahoma, the county seat of Garfield Co., situated about 100 mi. northwest of Oklahoma City. Bus lines and three railroads afford transportation. There is an excellent airport. The vicinity produces grain and live stock. Near by are extensive oil and gas fields. Enid is a large oil market and industrial center, marketing chiefly oil and wheat products, agricultural machinery and dairy produce. The manufactured output, 1929, amounted to \$10,447,045; the retail trade, 1929, was valued at \$19,661,845. Enid was founded in 1893 with the opening of the famous Cherokee Strip. Chisholm Trail is near by. Located here are Phillips University and a State Hospital for the Feeble Minded. Pop. 1920, 16,576; 1930, 26,399.

ENLIGHTENED DESPOTISM of the 18th century refers to the system of Governmental practices in vogue among the leading rulers of Europe from the middle of the 18th century to the period immediately prior to the outbreak of the French Revolution. Its primary purpose was national aggrandizement, with a concomitant promotion of population increase and an advancement of the general welfare. This ideal was to be realized through large and capable military power and skillful diplomacy (hence the incessant dynastic and colonial wars and the partition of Poland), sound finance and economic prosperity. Enlightened despotism, however, followed no uniform practices, varying from country to country and from time to time. Thus the enlightened despotisms of

eastern and northern Europe under Maria Theresa and Joseph of Austria, Gustavus III of Sweden, and Catherine the Great of Russia differed from that under Frederick II in Prussia as well as from that of Charles III of Spain and Pombal of Portugal.

The views of liberal philosophers of the Enlightenment and the Government policy of the enlightened despotism are not linked in a causal relationship. They are parallel but different embodiments of the spirit of the age. Not only is it difficult to prove that the former influenced the latter in any significant way, but one may show that the keynotes of the one were in sharp contrast with those of the other. The development and the nature of enlightened despotism may be found in such practical antecedents as (1) the Governmental policies of the Great Elector of Brandenburg and of Louis XIV and Colbert, in the activities of Frederick William I of Prussia and Victor Amadeus II of Savoy, in the ministries of Fleury in France and Walpole in England, and in the writings of the German legists and administrators, known as the cameralists. L. G.

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ENLISTMENT, a contract between a government and an individual by which the latter volunteers to perform military or naval duties in return for financial remuneration, food and clothing. It is used generally to describe the method of obtaining recruits in those countries which do not ordinarily use CONSCRIPTION.

To be eligible for enlistment in the army recruits must be between the ages of 18 and 35, if it is their first enlistment, and they must be able-bodied, of good moral character, i.e., never have been convicted of a felony nor imprisoned. They must be citizens, or have taken out naturalization papers, and they must be versed in the English language. In peace time the period of enlistment is one or three years, subsequent enlistments being for three years only. The adjutant-general's department has charge of the recruiting.

For enlistment in the Coast Guard candidates on original entry must be between the ages of 18 and 35; must be at least 5 ft. 4 in. in height, exception being made in the case of mess attendants; must be American citizens, or naturalized American citizens or have declared their intentions and so arranged that during enlistment they can not revert to alien allegiance while in the service. Enlistments are originally for three years, but in case of temporary service may be extended up to a total of three years. Candidates must be of good physique and pass the examination required by the Public Health Service.

In the Marine Corps the enlistment period is for four years, but many marines are permitted to extend their term of enlistment for short periods at their own request. A candidate must be between the ages of

19 and 35 to enlist; height from 5 ft. 6 in. to 6 ft. 2 in. Weight required must be proportionate to height. Nationality must be either native-born American or a naturalized citizen. Must be of good physique, sound and free from disease.

Enlistment period in the U.S. Navy is for four or six years, except in the case of minors between 17 and 18 years of age who are required to enlist for minority only, that is, until they reach their 21st birthday. They are permitted to extend their term of enlistment at their own request up to four years. A candidate must be between the ages of 17 and 35 to enlist; height from 5 ft. 2 in. in the case of minors and 5 ft. 3 in. in the case of adults to 6 ft. 4 in. Weight: proportionate to height. Nationality: either native-born American, a naturalized citizen or a native of U.S. insular possessions; of good physique, sound and free from disease; must be able to read and write the English language; must give a list of former employers or school teachers and furnish references. Written consent of parent or guardian must be secured in all cases where the applicant is under 21 years of age. J. N. G.; R. E. C.

ENNA, or **HENNA**, a city of Sicily, 3,000 feet above sea level, picturesquely situated near the center of the island about 100 mi. southeast of Palermo. It occupies a strategic position and was once strongly fortified. In the neighborhood are important sulphur and salt works. Five miles distant is Lake Pergusa where **PLUTO** is said to have seized **PROSERPINE**. In ancient times Enna was a place of worship of **Demeter**. It is also called by its ancient name, **Castrogiovanni**. Pop. 1931, 22,946.

ENNIS, a city in Ellis Co., northeastern central Texas. It is situated 33 mi. southeast of Dallas and is served by two railroads. The city is surrounded by a fertile cotton-growing region, and has cotton gins and compresses, cottonseed oil mills and railroad shops. Ennis was founded in 1872 and made a city in 1873. Pop. 1920, 7,224; 1930, 7,069.

ENNIUS, QUINTUS (239-169 B.C.), Latin poet, was born at Rudiae in Calabria, in 239 B.C. He served in the Roman army in Sardinia. From there, he was brought to Rome in 204 B.C. by Cato the Censor. At Rome he taught Greek and translated Greek plays for a livelihood, and won the favor of some eminent men, including the elder Scipio Africanus. Nevertheless, he passed most of his life in slender circumstances, and died of the gout at the age of 70. Ennius was a writer of astonishing fertility, his works covering almost every department of poetic composition. His renown rests chiefly on his *Annals*, the first national epic of Rome. It consists of 18 books relating in verse the traditional history of Rome, from the arrival of **AENEAS** down to the poet's own time. His other writings include numerous tragedies, besides some comedies, satires and precepts. Of all his works, only fragments remain.

ENOCH, BOOK OF, one of the books of the *Pseudepigrapha*. It consists of 108 chapters, and is the longest and most elaborate of all the *Pseudepi-*

grapha and of all the Jewish post-Biblical writings. It is ascribed to the Biblical Enoch (Genesis 5:21-24), a righteous man who "walked with God," although it was actually written at different times, probably in Palestine, during the first and second pre-Christian centuries by various hands. In its present form it is a composite work representing parts of many originally independent Jewish works which were combined, through various reworkings and revisions, as well as later insertions and interpolations. The different sections of the book as described below are assigned to different periods and authors who wrote for different purposes under varying circumstances.

The book was originally written either in Hebrew or in Aramaic. Both the original text and the Greek translation were lost or destroyed during the Middle Ages. There is also a Slavonic text of the Book of Enoch, taken from a translation in two recensions from a more recent Judeo-Greek text dating from before the destruction of the Second Temple in 70 A.D. The book purports to describe the journey of Enoch, who is pictured as a prophet, to the realm of God, where he is shown the secrets of nature and of the future Messianic kingdom; the sinful angels (cf. Genesis 6:1-3) and their fall are also described.

Chapters 1-5 form an introduction, an address by Enoch on God's final judgment to be pronounced over the world. Chapters 6-36 contain the narrative of the sin and fall of the angels, and of Enoch's wonderful journey through heaven and earth, *Gehinnom*, the abode of the fallen angels, and of Paradise and its tree of wisdom. Chapters 37-71 describe the future kingdom of God, the Messiah, and the bliss of the pious; the Messiah will one day rule over all the pious of the earth and over all the resurrected pious ones, and will repel the invasion of Jerusalem by the Parthians and the Medes. Chapters 72-82 contain geographical and astronomical data; in this section Enoch imparts to his son Methuselah, and thus to all mankind, various revelations concerning the angels. Chapters 83-90 contain two visions which Enoch had concerning the future history of mankind, including the vision of the 70 shepherds, and concerning the history of the period from Adam to the time of the Hasmoneans. The patriarchs, Israel, and the surrounding nations are symbolically portrayed as oxen, sheep and beasts of prey respectively. Chapters 91-108 contain various exhortations to Israel to practice justice and righteousness, and the exhortation to endure all hardships until the time of the end.

A. SH.

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ENOCH ARDEN, the title-character of a narrative poem by **ALFRED TENNYSON**, published (1864). Enoch is a sailor who, after being reported dead in a shipwreck, returns home after many years to find his wife married to his childhood friend, a discovery which causes his death.

ENOS or **ENOSH**, of the **BOOK OF GENESIS**, etymologically denotes "frail man." He was the son of

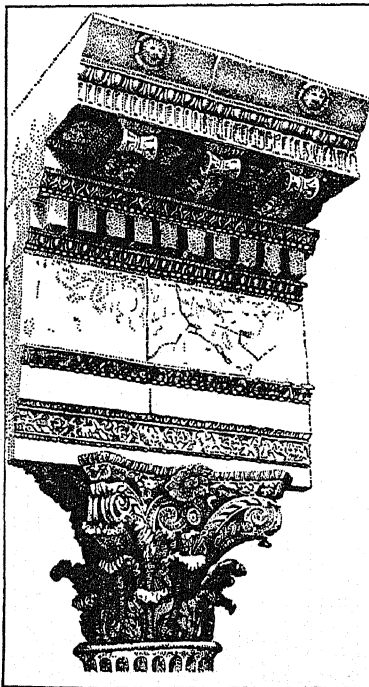
SETH, the grandson of ADAM, the father of Kenan and lived 905 years. In connection with his birth tradition adds, "Then began men to call upon the name of Jehovah," or as the Septuagint renders it, he was the first to call upon the name of Jehovah, which to some students indicates that his story is a legend of frail man's first prayer, although another tradition makes the sacrifice of Cain and Abel the first supplication to God.

ENRICHMENT, SECONDARY, in mining geology, the alteration by WEATHERING of near-surface ore bodies in such a manner that the lower portions of the deposit become enriched. See ORE ENRICHMENT, SECONDARY.

ENSCHDEDE, a manufacturing city in the Dutch province of Overijssel, located near the frontier of the Prussian province of Westphalia. Rebuilt after the fire of 1862, Enschede has modern homes for workmen, parks, a lyceum, and a people's university. Together with the neighboring village of Lonneker it is the center of the Dutch thread and cotton industry, having many factories and mills. Pop. 1930, 52,130.

ENSILAGE, or silage, for animal feeding. See ROUGHAGES.

ENTABLATURE, in classic architecture, the combination of architrave, frieze and cornice which is usually carried by a classic column or pilaster, and



COURTESY M. M. OF ART
ENTABLATURE AND CAPITOL. TEMPLE OF
CASTOR AND POLLUX, ROME

with it forms the ORDER; also, any similar combination of forms however used. The entablature was a natural decorative result of the methods of construction used in the primitive classic period. The architrave represents the beams bridging from column to

column; the banding of the Ionic and Corinthian architraves is merely the stone indication of an Asiatic manner of building up wooden beams out of planks. The frieze is the space once required for the cross-beams, whose ends are indicated in the Doric frieze by the grooved TRIGLYPHS; and the cornice is merely the elaboration of the roof overhang. The typical classic stone entablature still retains many decorative elements derived from a primitive wood construction. In Roman, Renaissance and modern architecture, the entablature, like many other classic forms, is used for purely decorative purposes.

ENTADA, a genus of high-climbing shrubs of the mimosa tribe of the pea family remarkable for the extraordinary length of their fruiting pods. There are about 20 species, widespread in tropical regions. They bear pinnately divided leaves, yellow or white flowers in axillary or terminal clusters and huge, flat, woody pods divided into many joints, each containing a large polished seed. The sword bean or nicker bean (*Entada scandens*) produces twisted pods, sometimes 8 ft. long, containing handsome dark brown or purple seeds or beans, 2 in. broad. The beans are often made into trinkets, match boxes, scent-bottles and other small articles. Sometimes the beans, which float and retain their vitality for a long time in sea water, are conveyed by the Gulf Stream and other great ocean currents from the West Indies to the shores of northwestern Europe. Nearly two centuries ago Linnaeus observed the germination of a seed on the coast of Norway.

ENTANGLEMENTS, the term usually applied to various types of barb-wire obstacles constructed in front of a defensive position to hinder the advance of attacking forces. Barb-wire entanglements are generally considered superior to other types of obstacles due to ease of construction, effectiveness as a barrier and immunity from destruction by enemy fire.

ENTASIS, the convex curve of the taper of a classic column shaft. From the earliest period of Hellenic Greek architecture, the taper of columns was not made with straight sides like the shape of a cone, but with a distinct swelling contour. When the difference between the upper and lower diameters of a column is great, it is said to have a large entasis. Usually, the greater this difference, the greater also is the curvature. In the earliest Greek Doric columns, the entasis is much exaggerated; later examples are more refined. See ORDER.

ENTENTE, an understanding between two or more powers as to common purposes and objects, and the means of cooperation to achieve them. An entente is less formal than an ALLIANCE, although the results may eventually be the same. The Franco-British Entente Cordiale is an example of an entente which does not amount to an alliance. The Triple Entente, unlike the Triple Alliance, a formal agreement between three powers, was made up of three bilateral agreements between three powers, each to the other, but not a tri-party agreement to which all three adhered.

ENTENTE CORDIALE. See TRIPLE ENTENTE.

ENTOMOLOGY. The branch of zoology which deals with the study of insects, is termed entomology. Derived from the Greek, *entomon*, an insect, and *logos*, science. Classification of insects; their form or structure; their physiology; their development; their habits; their life histories, often very complicated; all this, and much more, is rightly included under entomology. Discussion of the main features of the foregoing are presented in the general article on INSECTS and in various separate articles, as SOCIAL INSECTS, and also in the articles on the chief groups and on numerous individual species of insects. Economic entomology, or the study of those forms of insect life that are injurious to forests, field crops and domestic animals, is an important subdivision of this branch of zoological knowledge (see INJURIOUS INSECTS). The study of insects which are specifically harmful to man has been one of the fruitful fields of modern medical research and has resulted in many invaluable discoveries for the alleviation and prevention of dangerous diseases, as described in the accompanying article.

ENTOMOLOGY, MEDICAL, the branch of science which treats of insects and arachnids as agents in causing and transmitting disease and of the methods of control. The agents involved embrace a great variety of animal species belonging to the air-breathing arthropods which constitute the most numerous and widespread of all animal groups and include forms with which man comes in common contact in all lands. The different species affect man in divers ways and may be discussed with reference to the manner in which they disturb the normal condition of the human body. From this standpoint such organisms are: (1) venomous species, (2) parasitic species, (3) mechanical carriers or vectors, (4) disease breeders.

Venomous species are such as inoculate directly some toxic substance which produces lesions in the animal attacked. This inoculation may be carried out by biting mouth parts, by stings, or by dermal hairs. The biting species include a few spiders, some ticks and mites, and many blood-sucking insects. Spiders are not commonly poisonous and few can pierce the human skin. The large hairy spiders, though terrifying in aspect, are actually harmless. One small species, the black widow (*Lathrodectus mactans*) produces a venom that is a heart poison and its bite has been fatal in some cases. Some mites produce a severe irritation of the skin due to bites, though the so-called jigger mite, common in the Central States, does not bite but invades a sweat gland duct and perishes there. Such biting insects as mosquitoes, midges, fleas, lice, etc., annoy some persons greatly, whereas other persons are little affected.

The biting bugs are larger and more painful in action. Several types of bedbugs and the kissing bug of newspaper fame are representative of this group. The secretion of large so-called salivary glands is regarded as the cause of the irritation which accompanies the bite.

Stinging species include bees and wasps (Hymenoptera) among insects, and scorpions. The sting of the former is an ovipositor or egg laying organ which injects a poisonous secretion. In the scorpion, the abdomen terminates in a spine with poison glands; the sting is painful though rarely fatal.

Certain hairy caterpillars produce a serious dermal irritation when handled. Those of the browntail moth (*Euproctis chrysorrhæa*) of Europe and the eastern United States have barbed hairs with poison glands which break loose and penetrate the human skin. The blister beetles produce a volatile, highly irritating substance that has been used medicinally (cantharidin).

Parasitic species are such as feed in or on the body of a living host. Most of these belong to the group of flies (Diptera) and assail man in the young stage known as maggots. A few of the fleas and a considerable number of mites have the same habit. Infestations of the alimentary system are due to accidental ingestion of eggs or young in contaminated food and the subsequent discharge of these forms in the excrement. They are usually regarded as pseudoparasites and their stay in the human body is brief, though at times accompanied by abdominal symptoms. Blow flies may deposit eggs in sores or wounds and produce extensive lesions. This was observed often in the World War and strangely enough improved the condition of the wounded by consuming the dead tissues and reducing the toxic effect.

Many species of flies deposit eggs in the body orifices of various animals, and less often of man. In man the nasal cavity is the ordinary point of attack, and the developing maggots make serious and even fatal inroads on the adjacent tissues unless removed very promptly. Blood-sucking fly larvae that attack men are known in some tropical regions and one species of warble fly, the macaque worm (*Dermatobia hominis*), occurs in the skin of man in Central and South America.

The true "chiggers" of South America and western Africa are fleas that burrow into the feet of naked natives. The female is involved and chooses a location under the toe nail where, as the eggs accumulate, a huge swelling is produced that incapacitates the host for labor and may result in the formation of deep ulcers and the loss of the toes.

The mites furnish many examples of external parasitism. Itch mites burrow in the skin, excite the secretion of serious fluids that harden into the characteristic crusts present in this disease. The mites produce mange in domestic animals, and one species gives rise to a type of blackheads in man by its invasion of the sebaceous glands of the skin on portions of the face.

Mechanical carriers are responsible for the accidental transfer of disease producing germs. These they acquire ordinarily, by reason of their habit of visiting decaying materials for food or for egg laying. Prominent among these forms are the house-flies which carry germs on the hairs and deposit them directly

on exposed food or on tables or utensils from which the food is contaminated secondarily. It has been shown that certain germs pass unharmed through the gut of the fly and are deposited in the droppings where food may readily be contaminated. This sheltered transfer allows of wider dissemination of disease-producing organisms, since germs adherent to the exterior of a carrier are quickly killed off by drying and by sunlight. Cockroaches, croton bugs and even house ants may carry germs in similar fashion. One must recognize that oysters or even water plants coming from polluted waters and eaten raw, may also convey pathogenic germs into the alimentary system of man. (See also FOOD POISONING.)

All of the biting or stinging forms mentioned above may on occasion serve to convey to man disease-producing organisms. In these cases, the infection of the human host is doubly sure since the germs are introduced through the normally protective covering of the body into the living tissues. The germs of BUBONIC PLAGUE are transferred to man by the rat flea, but curiously in indirect fashion. The fleas, loaded with plague bacilli desert dead and dying rats, attack man and regurgitate the blood and with it the bacilli on the wound made by the bite. In this case there is a definite relation between the vector, or carrying agent, and the specific disease producing organisms which makes the affair rather more than merely mechanical. Thus it represents a phase that in a way is transitional from those involved in casual transportation to those discussed in the next section. The work done by mechanical carriers might be performed by a dirty rag or dish or by a sharp tool or broken fragment that had been polluted and hence the transfer is only casual.

Disease breeders play a much larger and more serious rôle. The insects and related arthropods include many species that participate most intimately in the spread of disease in that the pathogenic organisms pass an essential part of their life cycle within the body of such species which are accordingly termed alternative or intermediate hosts. Sometimes the part of the life cycle within the insect host is merely a period of growth, but in other cases it includes a reproductive period.

The first case is illustrated by many blood-inhabiting threadworms (Nematoda) like *Filaria bancrofti*, which is widely distributed in tropical regions and is associated with tropical ELEPHANTIASIS. The microscopic larvae in the blood stream are drawn into some mosquito during the act of biting; there they undergo growth changes and are later returned to a human host when after some days the mosquito feeds again. The stay in the mosquito is essential to the development of the worm and were it possible to destroy all mosquitoes, or to protect man absolutely from their bites, this parasite would be exterminated. Such a relation as that just described serves to insure the return of the parasite to the human host and provide it with means of entering the body, but it does not multiply the number of parasites. It is the condition

found regularly among verminous parasites and especially among the threadworms.

In other cases the biting insects may furnish opportunity for parasites to multiply during the part of the life cycle they shelter. Knowledge of this relation is recent and many protozoan parasites are known to undergo multiplication in the insect transfer hosts. The best known case is that of the malarial parasite (*Plasmodium*). Drawn into the mosquito's stomach (see MALARIA), the organisms in the human blood, if at the right stage of development, after completing the so-called sexual cycle, migrate into the wall of the midgut and there multiply to form masses of spores (sporozoites). These wander into the mosquito's proboscis and, in the secretion of the salivary glands, are injected into the body of a new human host. The cycle in the mosquito is an essential part of the life history of the parasite and during that period the numbers of the infecting organism are greatly increased.

Modern research in the new field of Protozoölogy has demonstrated the occurrence of similar conditions in many cases, including such as were long regarded as examples of merely mechanical transfer. These cases include some of the great world scourges, diseases that in epidemic form have ravaged the continents, such as MALARIA, TYPHUS, YELLOW FEVER, TRENCH FEVER, AFRICAN SLEEPING SICKNESS (trypanosomiasis), relapsing fevers and numerous lesser though serious maladies.

The development of methods for the control and prevention of insect-borne diseases forms an interesting and important part of the story of sanitary science and includes signal achievements in preventive medicine which alone is significant in handling such maladies. These studies have also been important in showing the close interrelation between human disease and that in other forms of animal life. See also INSECT BITES AND STINGS; PARASITIC DISEASES. H. B. WA.

ENTREPÔT, a warehouse, magazine, or mart where goods are stored temporarily, or in transit, or while being distributed; also, a place under the surveillance of customs officials where taxable imported goods are stored until re-exported. Entrepôt also designates a town with large distributive trade. See also FREE PORTS.

ENTREPRENEUR, the French term for the person who organizes, directs and assumes the risks of business enterprises. The entrepreneur, the business man, or the management, may be called the active factor in business enterprise, the passive factors being LAND, CAPITAL and LABOR. It is the function of the entrepreneur so to combine certain quantities of natural resources, capital, and labor, as to produce a salable product commanding a market price in excess of its costs of production. Costs of production include WAGES of labor, INTEREST on capital, RENT on the land employed, and outlays for materials and supplies consumed in the process of production. When business men in any industry compete with one another without restraint both in buying and selling there is a

strong tendency for average costs of production to equal or even exceed the average price obtained for the product, so that in the aggregate producers enjoy no net gain over COSTS OF PRODUCTION. The more able or fortunate, however, do enjoy a net gain, or profit, while the less able or fortunate suffer net losses. The entrepreneur may be said to make a profit when his net income from his business enterprise is greater than would be his income if he worked for wages or a salary, and lent his available capital to others at the current rate of interest. It is this possible net gain which induces the entrepreneur to assume the risks of business enterprise.

L. A. R.

ENTROPY, a mathematical function in THERMODYNAMICS which may be defined by the statement that if a body receives, or gives up, an amount of heat, Q , while at the absolute temperature, T , its entropy is increased, or diminished, by the amount Q/T . If the temperature is altered during the process, the change in entropy must be stated in the notation of calculus as $\int \frac{dQ}{T}$.

When the entropy of a body is altered *reversibly*, the change in entropy depends only upon the initial and final states of the body and not on any of the intermediate states. Mathematically, this means that change in entropy along a reversible path is an *exact differential*. Hence, calculations involving entropy are less involved than those which involve quantities, like change in heat, which are not exact differentials. When a substance is carried through a reversible process such as CARNOT'S CYCLE, the entropy at the end is the same as at the beginning. But for any process which is irreversible, an increase in entropy results. Actual physical processes in nature take place irreversibly. Hence, the statement: "The entropy of any system tends to become a maximum." In an adiabatic process (see ADIABATIC CHANGE), there is no change in heat content and therefore no change in entropy. For this reason, adiabatic curves are sometimes called *isentropic curves*, i.e., curves of equal entropy.

It is difficult to give any physical significance to entropy. Boltzmann defines the entropy of a physical system as "the logarithm of the probability of the mechanical condition of the system." W. W. S.

ENTRY, in coal mining, the combination of parallel and adjacent haulageways and airways giving access to the working places, and providing for their ventilation. According to the number of HEADINGS, the entry is termed a double, triple, or quadruple entry. A "butt-entry" parallels the main system of JOINTS, or "cleat" of a SEAM and a "face-entry" is perpendicular to it. Entry is frequently used synonymously with heading. See also CROSS ENTRY; MINING, COAL.

ENVER PASHA (1882-1922), Turkish statesman and general, was born at Apana on the Black Sea in 1882. He became affiliated with the Young Turk party and was one of the leaders of the Macedonian revolt of July, 1908, against Abdul Hamid. In the same year he was sent to Berlin as Turkish attaché,

but returned to Constantinople in April, 1909, to put down a counter-revolution and depose Abdul Hamid. He organized the Tripolitan opposition to the Italians which culminated in the Italo-Turkish war in Tripoli in 1911, where he took command in November of that year. Following the Peace of Lausanne (Oct., 1912), he plunged into the Balkan war against Turkey. During the armistice in December of that year which followed the Turkish defeat, Enver proceeded to Constantinople, overturned the government of Abdul Hamid who had been reinstated, ousting Kiamil Pasha and others in whose places Young Turks were substituted. In July, 1913, when Adrianople was evacuated by the Bulgarians, in a second Balkan war, Enver made a forced march and occupied the city. He made himself Minister of War in Jan., 1914. In the World War, he took command of the Turkish troops and, in the winter of 1914-15, led a Turkish army on a campaign on the Eastern Front. He was disastrously defeated by the Russians. For this and other failures, where his ambition overtowered his ability, he gradually lost his power in Turkish politics, and finally fled to Germany in Nov., 1918. In 1919, he went to Russia where he intrigued with the Russian Soviet against the Allies. Attempting a revolt against the Soviet in Turkestan, he was killed at Douchembe, Aug. 4, 1922.

ENVIRONMENT, the sum total of factors which surround an organism and which have an effect on its life. The word is used mainly in ecology and evolutionary theory, and is correlated with the word ADAPTATION, being taken to include those elements of the surroundings which are significant to the creature and to which it is adapted.

Environment is both inorganic and organic. In ecological work the emphasis is rather on the inorganic environment, in evolution both are of equal significance. Most of the physical factors of environment may be considered as either climatic or edaphic. See SOILS. Ecological classifications of the most varied character have been proposed, according as one or another factor is specially emphasized, but the following factors are most frequently used: temperature, light, moisture, and degree and type of variability among climatic factors; chemical composition, texture and moisture among soil factors. In the case of temperature some prefer to emphasize the mean temperature, others try to discover a formula which will base the classification on the heat available to growing plants; usually by counting only the excess temperature above a base-temperature below which growth is believed to be negligible (such as 40° F).

Another important factor is the occurrence of frost, for many tropical plants cannot live if frost occurs at all, regardless of the average temperature. In the matter of moisture one considers rainfall, soil moisture, atmospheric water and evaporation. In extremely arid areas the rainfall is likely to be a fair index of the available moisture, especially if allowance is made for the seasonal occurrence, but in humid areas evaporation may vary independently of

rainfall, especially near large bodies of water. A rough estimate made on the basis of the four Atlantic American stations where data on the point were available, indicates that effective humidity is about twice as high along the seacoast as would be expected from data on rainfall and temperature alone.

Another very important factor of the environment is light, both the total quantity and length of day. Major ecological units have not been made on the basis of this factor, but in the case of an individual species of plant or animal it is of primary importance. For this reason certain species are found flourishing only where they can get a certain minimum of direct sunlight, and in the case of some alpine flowers the total quantity of sunlight needed may be extremely large, while others can live only under dim lights, and so are commonly found only in the shade of other plants. A striking case in the commercial field is that of the coffee and chocolate trees, which cannot prosper under the full sunlight of the countries where they are grown, and must be cultivated under the shade of taller trees (frequently in practice the legumes *Inga* and *Erythrina* and other *Leguminosæ* which enrich the soil somewhat at the same time as they serve as a shade). The factor of length of day is plainly shown by some cultivated plants, for instance there are varieties of corn, tobacco and cosmos which will begin to bloom only when the day reaches a certain length.

Other ecologists prefer to emphasize the soil element of the environment, and make their major classification on the basis of texture, composition and water content. The subdivisions on the basis of soil texture are obvious, ranging from continuous rock, through scree, gravel, sand and loam, to clay and loess, but indefinite subdivision is possible, especially when the intimate mixture of several different grades occurs. A very important chemical factor in the soil is seen in the presence or absence of lime (calcium carbonate) which distinguishes soils as basic or acid; but other elements are also important factors, and soil types characterized by an excess of magnesia or of manganese, or by excess or deficiency of iron, phosphorus and nitrogen, are well known, and often may be the controlling factor of environments, producing distinctive associations.

In evolutionary theory environment is considered one of the major factors by both Lamarckism and Darwinism. (See LAMARCK; DARWIN.)

In actual analysis of a case it must be remembered that the entire environment is always present, and that the conspicuous factor may not be actually the crucial one, thus in the ecological field one may observe that a certain *Spiræa* is growing only in a swampy place, and assume that the species is limited by the factor of soil humidity, and yet the actual factor may be soil acidity, and the reason for the restricted growth may be the presence of lime in the soil, except in the area noticed, which only happened to be wet. Similarly in evolution, experiment has shown that a single factor or hereditary unit fre-

quently, if not always, causes a number of effects on the organism that carries it. The structure that catches our eye may be unimportant, and nevertheless may be correlated with differences in physiology that are actually of selective value. In that case continuous selection for the obscure (to us) physiological character will cause an apparently unmotivated but progressive change in the less important but visible character.

W. T. M. F.

ENZYMES, a word taking its origin from the idea that there is "in yeast" some substance whose peculiar properties make it active in fermentation processes. The sprouting of seeds, the life processes of plants and animals generally, and the process by which animals digest their food, all involve enzyme action. It is by virtue of such action that the chemical processes in living matter are made to go fast enough to support life. A common definition of enzymes is that they are the catalysts formed by living cells. But in actual practise the scientists who have most occasion to use the term do not employ it quite so broadly as this. Some, at least, of the hormones and vitamins are also catalysts, formed by living cells, though they are not ordinarily called enzymes. The actual amount of enzyme substance involved in the striking effects it produces is almost inconceivably small, and most of the enzymes are very unstable substances.

Although the existence of enzymes has been recognized for a century, there has until very recently been no consensus of opinion as to their chemical nature. However, through the study of a number of enzymes (presumably typical), it may now be considered established that they are of protein nature. But the precise difference between enzymes and ordinary proteins is still a subject for research.

H. C. S.

Enzyme action was first observed in the case of amylase by Kirchhoff, of St. Petersburg, in 1814. Amylase or diastase, the starch hydrolysing enzyme, converts starch to dextrin and maltose; because this catalyst is not used up in the reaction, as recently tested in purified form, some preparations are capable of digesting 4,000,000 times their weight of starch. Even further amounts could be digested by the same material were it not for the instability of the enzymes in the aqueous media in which they act.

The more general of enzymic conversions involve degradation from larger to smaller molecules. Starches are converted to dextrans and sugars successively by the amylases of the saliva and pancreas, proteins are converted to amino-acids by the pepsin of the stomach, the trypsin of the pancreas and the erepsin of the intestinal mucosa, fats are split to glycerol and fatty acids by the lipases of the stomach and pancreas. See also BIOCHEMISTRY.

R. P. W.

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EOCENE EPOCH, the first subdivision of the Tertiary Period in the CENOZOIC ERA of geological history. The term means "Dawn of the Recent," referring to the life of the time.

EOLITHS, literally dawn-stones, a name given to implements of flint, held to represent human workmanship, and older than the recognized beginning of the PALAEOLITHIC PERIOD, the first stage of which is known as PRE-CHELLEAN. George Grant MacCurdy and Henry Fairfield Osborn class as eoliths the remarkable implements found by J. Reid Moir in Norfolk and Suffolk, England, sites which both personally visited and explored. These sites have also been visited by Sir Arthur Keith, who fully recognizes the human workmanship of the implements found there. There is conclusive evidence that the men who made them were acquainted with the use of fire. Dr. Osborn is convinced that these implements are of older date than the Pleistocene, or Quaternary, and belong to the Pliocene or Upper Tertiary periods. The giant flint implements found at Cromer, Norfolk, in what is known as the Forest Bed of Cromer, now beneath sea level and exposed only at low tide, are probably of pre-Chellean age. See ARCHAEOLOGY.

EOS, in Greek mythology, the goddess of the dawn, identified with the Roman Aurora. The early morn-



EOS PURSUING THE YOUNG CEPHALUS
From an amphora in the Louvre Museum,
Paris

ing dewdrops are said to be Eos's tears shed for her son, Memnon; killed by ACHILLES in the Trojan War.

EOSINS, a group of valuable COAL TAR dyes of the xanthene type, which give brilliant colors. The eosins have a phenolic structure and are slightly acidic. They form unstable metallic lakes and their lead salts are employed in the production of bright red pigments. Commercial eosin ($C_{20}H_6O_5Br_4K_2$) is the potassium salt of a brominated fluorescein. It produces a rose-red color in silk, wool and mordanted cotton. Other dyestuffs of this series include safrosine or eosin scarlet (dibromodinitro-fluorescein) and rose benzol (tetraiodotetrachlorofluorescein). See also DYES, SYNTHETIC.

EÖTVÖS, BARON JOZSEF (1813-71), Hungarian novelist and statesman, was born at Budapest, Sept. 23, 1813. His father was a baron and a staunch upholder of the Habsburg rule. Nevertheless the young Eötvös was imbued with liberal-revolutionary ideas. After finishing his law course, he showed such literary promise that at 22 he was elected a member of the Hungarian Academy. When the Liberal Party, headed by Kossuth, achieved victory in 1848, Eötvös, the outstanding leader of the opposition party, was made Minister of Education. Eötvös was a prolific writer in many fields, but his present fame rests on his historical romances. Among these *The Carthusian Monk*, 1838, and the *Village Notary*, a Hungarian masterpiece that has received international re-

nown as a truthful picture of the various strata of Hungarian society. His political writings include *Prison Reform*, 1842 and *The State*, 1851. Eötvös died at Budapest, Feb. 2, 1871.

EÖTVÖS, BARON ROLAND (1848-1919), Hungarian physicist, was born at Budapest, July 27, 1848. In 1873 he became professor of mathematical physics at the University of Budapest and in 1889 was elected president of the Hungarian Academy of Sciences. He studied gravitational fields and motion problems therein and designed a delicate torsional mechanism, the Eötvös BALANCE, to indicate minute changes in the gravitational field, now used in oil exploration. He died at Budapest, Apr. 8, 1919.

EÖTVÖS BALANCE, a very sensitive TORSION BALANCE which will detect extremely small differences and changes in gravitational attraction caused by variations in the DENSITY of the earth's crust. It was devised about 1890 by Baron ROLAND Eötvös. The essential parts of this balance are shown in Fig. 1. It consists of a horizontal tubular beam supported by a platinum wire, *P*. A mirror, *m*, attached to the beam, is a means of observing, with a TELESCOPE and scale, the deflection, θ , of the beam. Two similar platinum cylinders, M_1 and M_2 , are supported at opposite ends of the beam. One is inserted in the end of the hollow beam; the other is suspended from the opposite end of the beam by wires of different lengths, or is inserted, like the other, in the end of the hollow beam. Fig. 2 shows the instrument with its inclosing case to protect the moving system from solar radiations.

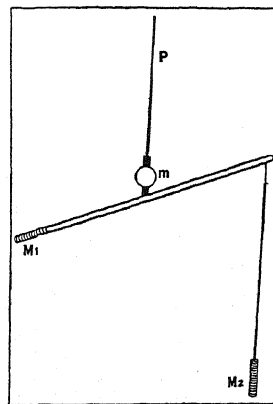


FIG. 1. ESSENTIAL ELEMENTS
OF EÖTVÖS BALANCE

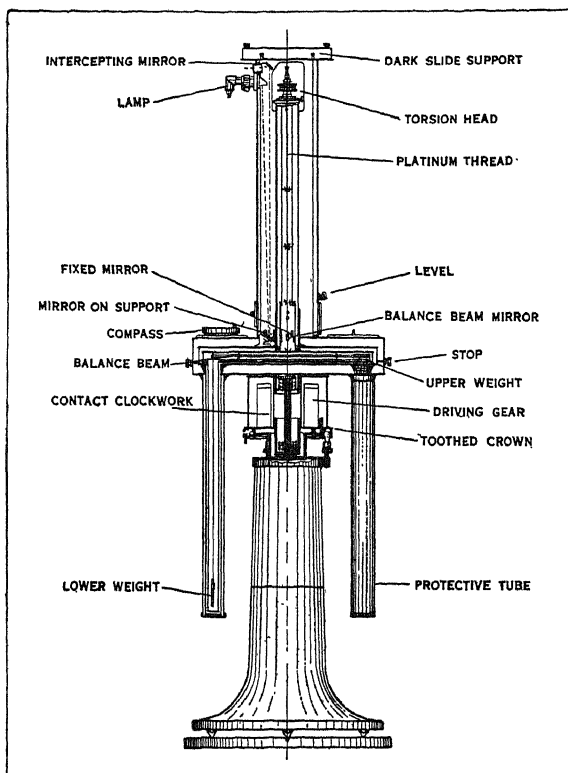
Suppose there is, in the earth's crust, a large deposit of metal, more or less isolated and having a density quite different from the average density of the earth. If the torsion balance is moved to various stations near the isolated mass of metal, its attraction for the suspended mass, M_2 , will be different than for the similar mass, M_1 , because the distances between the mass of metal and the two platinum cylinders are different. This difference in attraction will cause a deflection of the instrument. By means of a known mass, the instrument may be calibrated, so that the deflections due to the attraction of the mass of metal in the earth's crust may be evaluated.

For the location of valuable, metallic-ore deposits or oil domes, where there are marked differences in the densities of different sections of the earth's crust, the Eötvös balance has become very valuable.

While it looks formidable, nevertheless, the equation giving the deflection of the balance is a workable one. It is:

$$\theta = \frac{1}{2} \frac{K}{t} \left(\frac{\partial^2 V}{\partial y^2} - \frac{\partial^2 V}{\partial x^2} \right) \sin 2\alpha + \frac{K}{t} \frac{\partial^2 V}{\partial x \partial y} \cos 2\alpha - \frac{M_2 h l}{t} \cdot \frac{\partial^2 V}{\partial x \partial z} \sin \alpha + \frac{M_2 h l}{t} \cdot \frac{\partial^2 V}{\partial y \partial z} \cos \alpha$$

In this equation θ is the angle of deflection, M_2 the mass suspended on the long wire, V the potential of the gravitational force, K the moment of inertia of the moving system, l the length of the wire to which



COURTESY AMERICAN ASKANIA CORP.

FIG. 2. EÖTVÖS TORSION BALANCE

Cross section of a Schweydar model, showing platinum torsion wire, beam and weights, with triple casing to insulate parts from temperature changes. The balance is rotated by clockwork and the readings recorded photographically

M_2 is attached, h the distance of this wire from the axis of rotation, t the torsion constant of the fiber supporting the moving system and α the azimuthal angle of the beam from the x axis.

It is evident that nearby objects, such as large buildings, hills and mountains, have a marked influence on the deflection of the instrument. These deflections must all be accounted for and corrected. See also GEOPHYSICS.

R. W.

EPAMINONDAS (c. 418-362 B.C.), Theban general and statesman. After the Spartan garrison had been expelled from Thebes, in 379 B.C., Epaminondas organized the defence of Thebes against Sparta. In 371 B.C. at a congress in Sparta he refused to disband a league of Boeotian cities under Theban control. In the same year he won a notable victory over the Spartans at Leuctra in Boeotia, shattering

their reputation for invincibility. In 370 B.C. he led his army into the Peloponnesus, ravaging the territory of Sparta and liberating Messenia from Spartan rule. Eight years later after successful expeditions into the Peloponnesus he again overwhelmed the Spartans, at Mantinea, 362 B.C., but was mortally wounded. As a strategist and tactician he was brilliant, but his only permanent accomplishment was the overthrow of Spartan dominion in the Peloponnesus.

EPÉE, CHARLES MICHEL, ABBÉ DE L' (1712-89), French educator, was born at Versailles, France, Nov. 25, 1712. For a time he was canon of Troyes, but his acceptance of Jansenism led to his forced retirement from the Church. In 1765 he became interested in the education of two deaf mutes, which resulted in his devoting the rest of his life to working for the education of the deaf and dumb. The modern system of instruction for deaf mutes is largely based on his methods. In 1770 he founded an institution for the deaf and dumb, which long before his death became famous throughout the world. Epée died Dec. 23, 1789.

EPEUS, in Greek mythology: 1, son of ENDYMION, King of Elis, the ancestor of Epei. 2, Son of Panopeus who joined the expedition against Troy with 30 ships from the Cyclades. Epeus built the wooden horse with Minerva's help.

EPHEDRA, the botanical name for the joint firs, a genus of low, horsetail-like shrubs of the gnetum family found in dry alkaline soils. Certain species, particularly *E. sinica*, yield the powerful drug ephedrine. See JOINT FIR.

EPHEDRINE, a levo-rotatory alkaloid derived from a Chinese drug, ma huang (*Ephedra sinica*). Ephedrine is used in medicine in an oily solution and in the form of its salts, ephedrine chloride and ephedrine sulphate. Ephedrine acts somewhat similarly to epinephrine (see ADRENALIN), though less actively, its chief use being to reduce the swelling of the turbinates in the nose and for making ophthalmic examinations; unlike epinephrine, it does not decompose easily and therefore may be administered orally as well as locally.

EPHEMERIDA, the scientific name for an order of insects known popularly as mayflies. Members of this order differ from all other insects in shedding their skin once after they become winged. They have large eyes, short feelers, two or three long tail filaments, and usually two pairs of membranous wings, of which the front pair are larger than the hind pair. These insects spend most of their lives as water-dwelling nymphs, and live but a few hours or days as winged adults.

EPHEMERIS, the tabulated prediction, for given dates, of the position in the sky of any heavenly object. The more important ones are published for each year in a NAUTICAL ALMANAC.

EPHESIANS, EPISTLE TO THE, in the New Testament, appears to have been a circular letter addressed to the churches of Roman Asia, of which Ephesus was the principal port. The letter was

probably written between 61 and 63 A.D., although some recent scholars place it as late as 90 A.D., and deny that it was written by Paul, saying that its language is post-apostolic. Whatever its authorship and date, the epistle is unquestionably Pauline, and its place in the New Testament is amply warranted by the regard in which it is held by all Christians. It contains the exhortations to wives, husbands, children, masters and servants, which have ruled their relationships since the church was established.

EPHESUS, an ancient city on the west coast of Asia Minor, about 35 mi. south of Smyrna, was founded in the 11th century B.C. Ephesus was the most important of the Ionic colonies in Lydia and one of the first cities of the east. It was ruled by Croesus, King of Lydia, in the 6th century B.C. From 479 to 387 B.C. it was under the Persians and was then conquered successively by the Athenians, Macedonians and Romans. The Goths destroyed Ephesus in 262 A.D. The city was noted for its magnificent temple to Artemis and for its ancient theater and buildings, many of which have been restored. Heraclitus was born at Ephesus and St. Paul preached there.

EPHORI, a board of five officers elected at Sparta every year from an early date, who together with the GEROUSIA controlled the government. They possessed the highest executive power, presided over the senate and assembly, carried out its decrees, supervised education, inflicted punishments, suspended and arrested other officers, banished suspected foreigners, assessed fines and regulated public morals. Since they were elected from all classes of society by popular vote they were especially liable to corruption. L. K. B.

EPHRAIM, in Biblical account, a tribe of Israel founded by the younger and favorite son of Joseph. The tribe of Manasseh is similarly supposed to have descended from the elder son of Joseph. These two tribes are believed to have entered Palestine later than the other Hebrew tribes, and constitute what are historically known as the Joseph Tribes. The tribe of Benjamin seems to have branched off from Ephraim.

EPIC, a type of narrative poetry in which heroic action is described in noble proportion and style. The great Homeric *ILLAD* and *ODYSSEY* were probably preceded by other Greek epics and were certainly followed by various minor works in Greek, such as those by Peisander, Antimachus of Colophon and Panyasis. The first known epic in Latin is the *Bellum Punicum* of Naevius (d. about 194 B.C.). After Virgil, whose *ÆNEID* ranks as the greatest Latin epic, other of these narrative poems were written by Lucan, Cato, Statius, Valerius Flaccus, and Claudian, whose *Rape of Prosperine*, in the 4th century A.D., was the last ancient epic. Of "folk-epics," there are the Anglo-Saxon *BEOWULF*; the French *Chansons de geste*, of which the *Chanson de Roland* is the greatest; the Teutonic *Nibelungenlied*; and the Icelandic *Eddas*. Among the more important modern epics are Boiardo's *Orlando Innamorato*, 1486; Bello's *Mambriano*, 1497; Ariosto's *ORLANDO FURIOSO*;

Camoëns's *LUSIAD*; the Spanish *CID*; and, in English, Spenser's *FAERIE QUEENE* and Milton's *PARADISE LOST*.

EPICHARMUS (c. 540-c. 450 B.C.), Greek poet, was born on the island of Cos, about 540 B.C. In 484 B.C. he established himself at Syracuse. He wrote his comedies in the Doric dialect and introduced into them a plot in place of the buffoonery which had commonly prevailed. He was praised by Plato for his style and was paid the compliment of imitation by Plautus and Crates. Epicharmus is believed to have written 52 plays. He died at Syracuse about 450 B.C.

EPICTETUS (c. A.D. 50-?), Stoic philosopher, was born at Hierapolis in Phrygia, about the beginning of the Christian era. He lived for some time as a slave in the Roman house of Epaphroditus, a favorite freeman of Nero. Having somehow won his freedom, he became a professor of Stoic philosophy, which he had learned while attending the lectures of Musonius Rufus. In A.D. 90, Epictetus was banished from Rome by Domitian.

He retired to Nicopolis, Epirus, where he attracted many pupils, among them the historian Flavius Arrianus, who set down his master's teachings in two treatises: the *Discourses of Epictetus*, originally in eight books, four of which are extant; and a shorter work, the *Encheiridion*, or Handbook. The teachings of Epictetus were directed almost exclusively to a practical morality. Great emphasis is laid on the necessity of holding the mind independent of all external circumstances, since these are not under man's control. Man should strive to find all his happiness within himself, and should fear most of all the god within his own breast. The philosopher's favorite maxim was "bear and forbear."

EPICUREANISM, an ethical school holding that pleasure is the good. It derives its name from its founder EPICURUS. Although hedonistic in character, Epicureanism is a higher type of philosophy than is often supposed. The philosophy expressed in the words "Eat, drink and be merry, for tomorrow we die," a phrase often attributed to Epicurus, is not strictly a part of his teachings. It is much more characteristic of the CYRENAICS, who for the most part measured pleasure by its intensity. Epicurus, however, drew a qualitative distinction between pleasures, and he expressly advised cultivating those which were most enduring. Accordingly he stressed the pleasures of the intellect and particularly those of friendship. Like the Quakers, an Epicurean society was one of friends.

The goal of life for the Epicurean is ataraxy, a state of contentment and peace and of security against the storms of life. Starting with opposing premises the Epicurean reached somewhat the same conclusion as the Stoic. The Epicurean ataraxy, however, is more positive than the Stoic apathy. As a philosophy of life, Epicureanism found one of its best expressions in the *De Rerum Natura* of LUCRETIUS. Horace, Caesar and Pliny the Younger were other illustrious Roman followers of Epicurus.

EPICURUS (337 or 341-270 B.C.), Greek philosopher, was born at Samos of Athenian parentage.

Influenced by the superstitious nature of his mother, he became convinced that it is the fear of the gods that is responsible for much of the unhappiness in the world. He thus regarded it as his duty to enlighten people against such fears and he became the enemy of religion. Toward this end he adopted the philosophy of DEMOCRITUS with but little modification. He settled in Athens in 306 B.C., and the school that bears his name was founded at this time. Epicurus was very popular among his followers. Unfortunately, most of his writings have been destroyed; but a few of his letters have come down to us through Diogenes Laertius. He died in 270 B.C. *See* EPI-CUREANISM.

EPICYCLOID, a curve traced by a point on a circle C which rolls on the convex side of a given circle K . The Cartesian equation is

$$(x^2 + y^2 - a^2)^2 = 4a[(x - a)^2 + y^2].$$

The curve was recognized by Hipparchus (c. 140 B.C.) and was first described in print by Albrecht Dürer (1525). It was extensively studied in the 17th century. If C rolls on the concave side of K the resulting curve is a hypocycloid. *See* CURVES.

EPIDEMIOLOGY. Two of the modern weapons of public health are bacteriology and epidemiology. Many of our older and sometimes successful health officials regard them as synonymous. As a matter of fact, lemology or lemography, meaning the sum of human knowledge as to pestilence, was known long before the science of bacteriology came into existence. The terms epidemiology and bacteriology are more frequently used to-day, and oftentimes their application to problems is quite misunderstood. Where disease affects the individual, the problem is that of the physician. Should this disease be of a communicable nature, like influenza, then the locality, the city, the state, the nation or the world may become involved. On the other hand, diseases that are not communicable, such as heart disease but which may have some definite and perhaps controllable feature which can be applied to the population as a whole, may well come into the scope of epidemiological study. Likewise, the effect of disease upon selected groups, or as to age, sex, environment, weather and climate, or occupation and even emotional and religious factors, plays a part. Therefore, epidemiology is a science with many ramifications, giving graphic or word pictures of the occurrence, incidence, distribution, the infectivity, virulence of the causative microbic or viric factor and the seasonal or calendar periodicity, both present and past. Necessarily, the epidemiologist must have a broad training in bacteriology, immunology, medical zoology and parasitology, statistics, public health administration and sanitary engineering.

Statistical Epidemiology. Epidemiology as an entity must have a starting point and this is usually statistical. A maximum of information should be sought of the attending physicians and the more complete and prompt the reporting of disease, the more accurate will be the premises adopted, and presumably the control. Standard regulations cover about 42 noti-

fiable diseases. The discerning health official must have daily, weekly, monthly, or perhaps better, all of these reports as to the presence and number of cases of disease with graphic charts as to their location at the time of reporting and the previous movements of those ill. Moreover, knowledge should be available for fixed periods of years, months and weeks of past incidence measured arithmetically in terms of an average for the non-epidemic period, the so-called "norm" or expectancy, but corrected to population estimates. Such averages, when plotted into curves, may give reasonable endemic or constant seasonal information. Furthermore, these endemic or constant averages, when subjected to percentage calculations against the reported cases, will give us roughly the epidemic index. For instance, if the expectancy or norm or endemic constant is 50 cases of a disease for a given locality for any particular period of time, say a month, and the number of reported cases is 100, then the epidemic index in percentage would be 200, basing the normal on 100. With such information and with care given to deviations, such as changes in population, etc., the health official has useful data for collation purposes and forecasting.

Field Epidemiology. Having disposed of statistical epidemiology, let us step to field epidemiology. The discovery of the microbic or ultra-visible or viric cause of disease, or the parasite with or without its intermediate host, together with the manner of spread from person to person, has added many new points to epidemiology. Furthermore, the transference of animal diseases to humans, such as the undulant fever group, has focused attention to this not unfertile source of human infections. The mode of spread of many diseases, however, is still obscure; for contact with the case, or with the healthy carrier or the missed cases, accounts for the spread of many diseases.

One of the difficulties not yet surmounted is the apparent power of a microbic or ultra-visible virus to produce serious or mild cases, or produce few cases at some period or for several periods, or cause epidemics or inter-epidemics (the so-called recurrences), or great pandemics.

It is an attractive hypothesis to assume, in order of importance; that the virus of a disease like influenza is widely distributed; that individual and even racial susceptibility plays an important rôle; and that the virulence of pandemic strains subsides for years or becomes innocuous. Microbic or viric dissociation from a virulent to a non-virulent status has been suggested as a possible explanation of certain vagaries in the epidemiology of communicable diseases, particularly that of epidemic cerebrospinal fever (meningitis), but at present this is not quite susceptible of proof. For instance, the facility and frequency of the occurrence of influenza is very manifest, as is its dual epidemiologic rôle of pandemic and inter-epidemic. Possibly exaltations in virulence do occur. Two epidemiologic facts stand out prominently as to the 1918 pandemic of influenza: that the so-called first wave was relatively trivial and occurred in the spring and that the second

wave was more explosive, more dangerous, more dispersive, more incapacitative, more depressive of mind, reaching the crest in October-November of the same year. Possibly this might be considered as a "tuning up" process of the virulence of the causative factor.

Many diseases, especially measles and scarlet fever, are commonly supposed to occur in cycles or at periodic intervals. This periodicity is assumed to be due to an accumulation of susceptibles. Conversely, why certain diseases appear year after year with seasonal regularity is likewise not susceptible to proof to-day. Certainly, malaria to become epidemic in a community is dependent upon several factors. These are: the existence of human carriers of the parasite, and the presence of such parasites in the blood in sexually differentiated forms; the number of infected mosquitoes of a suitable variety and the extent of breeding areas and of breeding, and their proximity to human blood. It is perfectly true, however, that even then, infection may depend upon the weather and temperature, for no matter how perfect the type of insect host or the number of carriers, the female mosquito will not convey malaria when temperatures are too cold.

Climatic conditions certainly seem to affect other diseases and their virulence, particularly those emanating in the tropics. For instance, African sleeping sickness is apparently limited to certain regions suitable to the tsetse fly. Likewise this is comparatively true of Rocky Mountain spotted fever and its tick vector in our own West and even the case mortality which varies as to the state. Bubonic plague depends upon the infected rat or other rodents and the flea, and generally upon humidity.

Of all our epidemiologic factors, environment plays a most important rôle. The vitality of the race or the natural resistance to disease must assert itself in many ways and this may depend upon certain dietary factors (the vitamins). Fatigue is considered a marked factor in tuberculosis and cholera; sunlight is an added preventive against pneumonia; the smoke nuisance in cities, overcrowding and improper housing, undoubtedly play their part in the spread of respiratory infections and epidemic cerebrospinal fever (meningitis); while unsanitary water supply, milk and food supply are sources of infectious diseases, such as typhoid, tuberculosis, food poisoning.

Research in Epidemiology. There is no doubt that research in epidemiology, especially experimental, is needed in order to understand factors as yet unexplainable. In any event, the use of toxin-antitoxin or toxoid as preventive measures against diphtheria and of vaccination against typhoid fever and smallpox, has had a remarkable effect in the reduction of these diseases. Finally, though preventive medicine and sanitation have not eliminated disease, they have held pestilence in check. Because of rapidity of travel to-day, especially by air, with its associated possibility in the spread of disease, epidemiology, more than ever, must take its place as a protective medical and public health science to modern civilization. There is no evidence that microbes or the ultra-visible viruses are

becoming senile, though some diseases have surely become less frequent as hard-gained knowledge is applied to reasonable control measures. *See also* BACTERIA; ENTOMOLOGY, MEDICAL; IMMUNITY; INFANTILE PARALYSIS; MILK INSPECTION; QUARANTINE; SANITARY ENGINEERING; TROPICAL MEDICINE; TYPHOID FEVER; WATER PURIFICATION; YELLOW FEVER. J. C. G.

EPIDOTE, a rock-forming silicate, usually of peculiar pistachio-green color but which may vary to brown and black, also red, yellow and colorless. It is transparent to opaque. Epidote is a hydrous calcium aluminium iron silicate, crystallizing in the MONOCLINIC SYSTEM, commonly found in such rocks as syenite, gneiss, mica schists and serpentine. *See also* ZOISITE; METAMORPHISM.

EPIGRAM (originally meaning an inscription), a pithy thought, generally stinging satirical, compactly expressed in verse or prose. Among the ancient Greeks the epigram was simply an inscription, terse and unadorned. Of Latin epigrams, those of CATULLUS and MARTIAL take first rank despite their frequent obscenity. The poets of 16th century England were ardent epigrammatists, shaping their wit into brilliant pieces of from two to eight lines each; the greatest of the Elizabethans was JOHN HEYWOOD (d. 1604) who composed some 600 epigrams. The great English poets have all written more or less successful epigrams, but of them all ALEXANDER POPE is easily the greatest master. In France there have been epigrams by MAROT, St. Gellais, BOILEAU, Lebrun, Piron, VOLTAIRE and others. Noteworthy American epigrammatists have been Ambrose Bierce and Mark Twain.

EPILEPSY, a chronic disease of the nervous system characterized by periodically recurring convulsions, lapses, or abnormal mental states, occurring in an individual with a constitutional inferiority or personality defect, but with as yet, no consistently demonstrated pathologic lesion.

The disease has been known since ancient times, and was described by Hippocrates (460 B.C.). Among the ancients the disease was considered a manifestation of divine visitation. The more superstitious regarded it as a trance in which the affected was in communication with Deity. Later it was regarded as a possession of the devil. The frequent occurrences of epilepsy in children, however, cast doubt upon the popular superstition. It is only in recent times that the various frequent convulsions in infancy and childhood are becoming better understood and properly classified and epilepsy has emerged as a disease entity. Here we are not concerned with convulsions arising from a definite injury or disease process of the brain, such as brain hemorrhage, skull fracture, brain tumor, meningitis, encephalitis, etc. Hysteria and hysterical seizures are also excluded from this consideration.

Elaborating upon the definition given above, the disease involves only the nervous system, it is chronic and usually progressive, and its manifestations tend to recur at periodic intervals though this feature develops later as the disease becomes established. All convulsions, even

those recurring periodically, are not epileptic and all epileptics do not have convulsions. Some individuals have typical so-called grand mal or major seizures, convulsions, or fits. Others have petit mal or minor seizures, which are transient or fleeting losses of consciousness and do not involve muscular twitchings. Others still have recurring periods of abnormal mental states during which they suffer the so-called "epileptic equivalents" but have neither fits nor even temporary losses of consciousness. During their seizures or "equivalents" they suffer from disturbances in mentality when they lose control of their inhibitions or conduct regulating mechanisms. The constitutional inferiority or personality defect implies an inherited peculiarity of the nervous system which makes these individuals temperamental, irritable, excitable, and emotionally unstable. This does not imply that they are mentally retarded; on the contrary, during the early stages of the disease the children are often mentally precocious. Thus far no definite pathologic lesion or process in the brain has been proven to be the cause of the disease.

Idiopathic or essential epilepsy, that form of the disease which is distinguished from the convulsions arising on an organic basis or a true demonstrable disease process, is probably transmitted through heredity as a Mendelian dominant. The disease is found in the uncles, aunts, cousins, or grandparents, usually at least one generation removed. It is seldom found in the parents of the patient. On the other hand, the manifestations of the nervous system instability are often evinced in the parents in the form of nervous irritability, nervous breakdowns, sick headache, etc.

The disease may begin at any age, but it is not common in the first few years of life. The majority of epileptics have their first seizure between five and fifteen years of age. It may begin as the petit mal form. The child has spells of staring into space when he does not respond to questions; after a few seconds the spell is over and the child continues his former pursuit or he may then answer the question. These spells occur only when the child is awake and are often attributed to indifference by the parents. While petit mal spells are mild and transient in character, they are fully as serious as and usually develop into the major form of epilepsy.

The grand mal or major convulsions often begin at night. If the child is not under close observation, the preliminary attacks may be missed. The only evidence they may leave is a disheveled or soiled bed, or the patient may awaken late with a headache and a tired, irritable feeling. The attacks increase in frequency and severity and then occur in the daytime. When the attacks occur during waking hours, about half of the patients have *aurae* or an unpleasant sensation which they soon learn to interpret as the forerunner of a seizure.

In children, epilepsy is usually associated with peculiarities in food habits, overindulgence, and constipation. In adults, the attacks are associated with emotional strains, excesses, and overindulgences, especially

in alcohol, and with confinement in poorly ventilated and hot enclosures or in crowds.

Repeated attacks of epilepsy make the individual self-conscious and emphasize his temperamental peculiarities. The constant fear of attacks, particularly in crowds, induces their recurrence, while isolation in an epileptic colony or on a farm diminishes their frequency. Repeated convulsions damage the brain and finally leave a scar. This sets up a vicious circle, in that the permanent scar or injury induces more attacks.

The treatment of epilepsy has offered one of the most difficult problems in medicine. Consequently it has also offered one of the most lucrative fields for charlatans and quacks. There are several hundred "cures" for epilepsy advertised to-day, thus proving, as in cancer, that there is no one cure. Since the time of Hippocrates it has been shown that fasting, purging, and change of environment exert the most beneficial effect on the disease. These measures form the basis of the most rational modern treatment. The present scientific efforts are directed at the disease and not only at the symptom, convulsions.

Within the past ten years two new therapeutic regimens have been discovered in America. These procedures, which have produced the most favorable results thus far reported, are both closely related in principle and have been developed on the basis of the common knowledge that fasting is the most effective measure known to relieve the convulsions of epilepsy. These new dietary treatments may be used alone or in combination with drugs. They are familiar to all students of the disease. The vegetarian, salt-free, milk-only, natural-food diets, and such have no logical basis and have not become established.

Very few drugs are effective in the treatment of epilepsy. They are merely adjuncts in therapy and are directed at "convulsions" rather than at the disease complex. A renewed interest has been stimulated in this disease, formerly considered incurable, and considerable investigation is under way in the United States. The hereditary transmission of the potential disease must always be kept in mind. *See also* COMA; CONVULSIONS. M. G. P.

EPILOGUE. *See* PROLOGUE AND EPILOGUE.

EPIMETHEUS, in Greek mythology, brother of PROMETHEUS and son of the Titan Iapetus and Clymene. ZEUS, in anger at Prometheus for stealing fire from heaven for mortals, gave Epimetheus PANDORA, who let loose from her box all the ills and diseases of man. Epimetheus means afterthought and Prometheus, forethought. Epimetheus was father of Pyrrha.

ÉPINAL, a fortified industrial city located on the Moselle River in northeastern France and capital of the department of the Vosges. It has an interesting 11th-13th century church, a museum and a valuable library. The chief industries are cotton spinning and the manufacture of images. Pop. 1931, 27,350.

EPINAY, LOUISE TARDIEU D'ESCLAVELLES, MADAME D' (1726-83) French writer,

was born at Valenciennes, Mar. 11, 1726. She married her cousin, but the marriage was unhappy and the couple separated. She later became the intimate friend of JEAN-JACQUES ROUSSEAU, and provided for him a small cottage, The Hermitage, near her château at Montmorency. She was also a friend of Baron Von Grimm, who was responsible for directing her to more serious pursuits than she had hitherto followed. In 1774 she wrote *Les Conversations d'Emilie*, which was very successful and was crowned by the Academy. Her *Mémoires et Correspondence* are widely read for the vivid light they throw on contemporary French society. Madame d'Epinay died in Paris, Apr. 17, 1783.

EPINEPHRINE. See ADRENALIN.

EPIPHANIUS, ST. (c. 315-403), a Father of the Eastern Church, was born near Eleutheropolis, Palestine, about 315. In 367 he was created bishop of Constantia in Cyprus. His life appears to have been spent in theological contentions, especially with heresies affecting the doctrine of the Trinity. He was present at the synods of Antioch and of Rome. He wrote several works on Christian doctrine, and a book against heresies entitled *Panarion*. He died at sea near Cyprus in 403, returning from Constantinople, to which city he had been called to oppose the teachings of ORIGEN.

EPIPHANY, variously known as Twelfth Night, Old Christmas Day, Festival of Lights, Three Kings' Day and the Festival of the Magi, derives its name from the Greek word meaning to show forth. The Christian churches celebrate the day to commemorate the appearance of the Magi, or the appearance of the star of Bethlehem to the Magi, or the "showing forth" of God's approval at the baptism of Jesus in the Jordan, all intended to symbolize the manifestation of Christ as "a light" to enlighten the Gentiles. It is first mentioned by Clement of Alexandria (c. 194 A.D.). In Spain, where it is called Three Kings' Day, manglers of straw are built in every home, in which the children find their gifts, and a gorgeous procession visits the orphanages. In Italy it is the day of Befana, a female St. Nicholas, who flies in at windows and down chimneys with children's toys. Befana Toy Fair in the Piazza Navona in Rome is a notable event on this day.

EPIPHYTES, a large group of botanically unrelated, light-demanding plants, that are attached mechanically to trees, buildings or even telegraph wires. Often mistaken for parasites, they take no food from their supporting perch, the advantage of which is to obtain more light and air. Epiphytes are common in the tropics but rare in the temperate zone. Orchids, many ferns, some cactuses and many plants of the pineapple family are often epiphytes. Such plants have special mechanisms for the absorption of food from the air, and are thus often called air plants. See BROMELIAS; LONG MOSS; PARASITIC PLANTS; ORCHIDS; VANILLA.

EPIRUS, a country of ancient Greece, lying in the northwestern part of Greece and southern Albania.

One of its most celebrated kings was Pyrrhus (see PYRRHIC VICTORY), who ruled in the 3rd century B.C.

EPISCOPAL CHURCH. See PROTESTANT EPISCOPAL CHURCH OF THE UNITED STATES.

EPISTEMOLOGY, the science of knowledge. It is that branch of philosophy which investigates the conditions, the presuppositions, the possibilities and the limitations of human knowledge. Epistemology would go beyond science in that it examines the canons of scientific knowledge.

Historically, metaphysics preceded epistemology. It was only after men began to inquire into the nature of existence that the knowledge-problem came to the front. The SOPHISTS first questioned our ability to attain truth, and the sceptics (see SCEPTICISM) pointed out the limitations of the senses in the acquisition of knowledge. In modern philosophy epistemology plays a most important part, but there is a tendency to react against it at the present time.

EPISTLE, an elegantly formal or didactic letter in prose or verse; a letter addressed by an apostle to distant brethren, as in the *New Testament*; or a selection appointed to be read in the Communion service of liturgical churches, after the collect and before the Gospel. Unlike ordinary letters addressed to an individual, epistles are generally written to or for a group of people. Outstanding collections from ancient writers are perhaps those of SENECA, PLINY THE YOUNGER and CICERO; the Christian Fathers also left important writings in this form. The epistle in verse, which was revived by PETRARCH, was introduced in the 16th century by CLÉMENT MAROT in France, and in England by SAMUEL DANIEL. ALEXANDER POPE wrote probably the finest metrical epistles in English.

EPITAPH, a commemorative piece in verse or prose, at first inscribed on a tomb. The earliest known epitaphs are those of the ancient Egyptian sarcophagi, giving merely the name of the deceased, family and condition, with an invocation of some deity. The epitaphs of the Greeks (the earliest from Thera, dating from about the 7th century B.C.) were at first mere records of fact but later became works of marked literary value. Roman epitaphs, simple registers of fact, were often preceded by the letters D.M. or D.M.S. (*Dius Manibus* or *Dius Manibus Sacrum*), letters which curiously enough appear in many of the Christian epitaphs in the catacombs. In Elizabethan times, English epitaphs supplanting those in Latin or French became definitely literary. SAMUEL JOHNSON, the author of a notable essay on epitaphs, considered ALEXANDER POPE the greatest English epitaphist. In America, many curious epitaphs may be found in old churchyards.

EPITHALAMIUM, the name given by the Greeks to the song celebrating the bride and groom on their wedding night. Sappho, Anacreon, Alcman, Pindar, Stesichorus and others wrote beautiful epithalamia, though it was THEOCRITUS who wrote perhaps the finest in his 18th idyll celebrating the marriage of Menelaus and Helen. In Latin, the greatest epi-

thalamist was CATULLUS. Later ages have produced notable epithalamia; in French by RONSARD, Malherbe and Scarron, in Italian by Marini and Metastasio, and in English by SPENSER, BEN JONSON, DONNE, QUARLES and TENNYSON.

EPITHELIUM, one of the main groups of tissues of the body. In general they have one free surface and are an aggregate of cells variously arranged, but with very little intercellular material. They are specialized for protection or for secretion. See HISTOLOGY.

Each of the distinct types is associated with definite locations in the body. Epithelia composed of but a single layer of cells are *simple epithelia*, those having more than one layer are *stratified epithelia*. *Simple epithelia* composed of thin polygonal disk-like cells in

by the deeper layers take their place. Stratified columnar epithelium lines some of the male genital passages. The epithelium lining the bladder is composed of cells which alter their shape and relations according as the organ is empty or full. This type is termed *transitional epithelium* (Fig. 6). W. J. S. K.

EPSOM SALTS, the common name used by the laity to designate magnesium sulphate. See MAGNESIUM, SALTS OF; CATHARTICS.

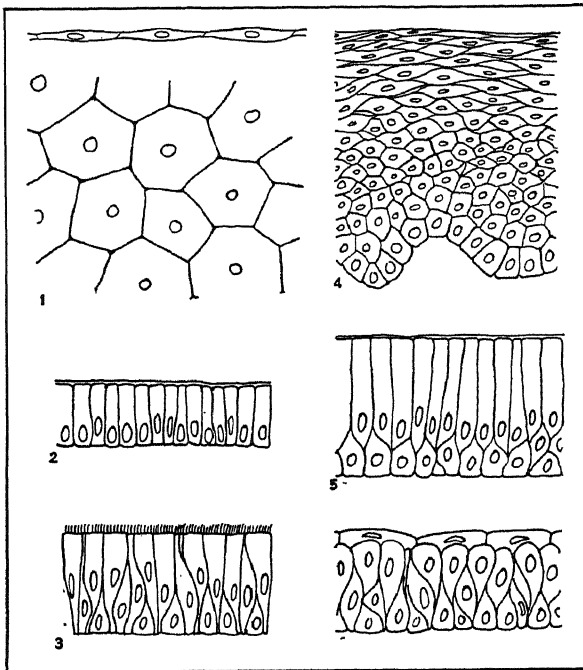
EPSTEIN, JACOB (1880-), Anglo-American sculptor, was born in New York in 1880 of Russian-Polish parents. He studied at the Ecole des Beaux Arts, and at Julian Academy, Paris, and settled in London. His principal works include 18 figures for the British Medical Association Building; a memorial to W. H. Hudson; two groups, *Day and Night*, Underground New Building, all in London, and the tomb of Oscar Wilde, Paris. He has executed portrait busts of Ramsey MacDonald, Admiral Lord Fisher, Joseph Conrad, the Duchess of Hamilton, Lady Gregory and John Dewey. His *An American Soldier* is in the Metropolitan Museum, New York.

EQUALITY OF STATES, a principle of international jurisprudence that every state is in law and before the law the equal of every other. Thus, all states, whether weak or powerful, have the same rights and obligations and are equally entitled to such redress as international law may afford for the violation of any right. In the absence of an effective international sanction, however, weak states are actually at a disadvantage in securing respect for their rights as against the strong.

EQUALIZATION FEE. In the various McNary-Haugen bills (see McNARY-HAUGEN LAW) providing for removal of parts of the supplies of certain major farm products from the American market and their sale abroad at prices lower than those prevailing in the United States, provision had to be made for reimbursing the FEDERAL FARM BOARD for the losses thus incurred. The plan of reimbursing with scrip sold at face value and repurchased at a DISCOUNT met with much opposition. The second and later bills provided that the board should, "prior to the commencement of operations in respect of any basic agricultural commodity, and thereafter from time to time" estimate the probable losses and costs for the removal of such commodity; determine the amount of an equalization fee properly chargeable to each unit of weight, measure or value, of the commodity; and provide for the collection of this fee through transporters, processors or buyers of the product under regulations to be established by the board. See also FARM RELIEF.

J. D. B.

EQUAL RIGHTS ASSOCIATION, in Canadian history, an anti-Catholic order formed in Ontario to conduct agitation against clerical privilege. D'Alton McCarthy, a leader, attempted in the Dominion Commons to have the French language forbidden in official proceedings of the Northwest Territories. The association also favored a preferential tariff for British imports. Though failing after a virulent national



DIAGRAMS OF TYPES OF EPITHELIA

Fig. 1, *Simple squamous* (section and surface views); Fig. 2, *simple columnar*; Fig. 3, *pseudostratified*; Fig. 4, *stratified squamous*; Fig. 5, *stratified columnar*; Fig. 6, *transitional*

contact by their edges are referred to as the *simple squamous* type (Fig. 1). The entire circulatory system is lined with such cells. If the simple epithelium is composed of tall prismatic columns, it is *simple columnar epithelium* (Fig. 2). This kind of tissue lines the digestive tract below the esophagus. A modification of this type composed of pyramids or truncated pyramidal cells arranged in sacs is a common type of epithelium comprising glands. The cells of the simple epithelium lining the respiratory tract appear to be several layers in thickness, but a portion of each cell touches the basement membrane. This is *pseudo-stratified columnar epithelium* (Fig. 3).

Stratified epithelia may also be *squamous* (Fig. 4) or *columnar* (Fig. 5). The former is the most resistant to wear and accordingly forms the skin. As the outer dead cells are worn off, new ones produced

campaign to secure disallowance of the JESUITS ESTATES ACT, the order continued a force in provincial politics. It preceded and outlived the PROTESTANT PROTECTIVE ASSOCIATION.

EQUAL RIGHTS PARTY, a political organization in New York State, 1835-37, principally opposed to the system of chartering banks by separate legislation. Its members were derisively called Locofocos. The party was formally organized in Jan. 1836, and its platform declared that no legislature had the right to exempt corporations by special charters from the operation of any law, or to grant special privileges to any corporation, and denounced paper currency. Having won several minor offices in 1836, in the New York City election early in 1837 the party cooperated with the Whigs to overthrow the Democratic régime. Its financial planks were substantially repeated by President Van Buren in his message to Congress, Sept., 1837. The party secured the desired revision of banking laws in New York State in 1838 and dissolved.

EQUAL TEMPERAMENT, a division of the musical scale into twelve equal intervals; *see* TEMPERAMENT.

EQUATION OF EXCHANGE. *See* QUANTITY THEORY OF MONEY.

EQUATION OF LIGHT, a small correction which has to be applied to the observed instants of celestial phenomena, to allow for the difference in time consumed by the light rays in reaching the earth in various positions in its orbit.

EQUATIONS. An *equation* is the expression of equality between two quantities. It is perhaps the greatest instrument that was ever devised for the solution of problems in mathematics and science. Any statement of equality, such as

$4 = 4, x + 2 = 12, x^2 + 2xy + 3y^2 = 0,$ forms an equation. Since the symbolic language of ALGEBRA is concise and clear, the equation offers a simple way to express facts which often seem intricate and complicated when expressed in our everyday language.

An equation containing one or more letters is said to be satisfied by any values of the letters which will make both sides or members of the equation equal. For example, in the equation $2x + 7 = 17$, it is evident that $x = 5$ satisfies the equation. A number which satisfies an equation is called a root of the equation. In this case 5 is a root of the equation $2x + 7 = 17$.

An equation such as $\frac{x-1}{x-1} = x+1$, which is true for every value of the unknown for which the equation has a meaning, is called an identity. An equation which is satisfied only by certain values of the unknown is called an equation of condition. Two equations are equivalent if every number which satisfies one of them satisfies the other also. Thus $x + 2 = 7$ and $2x + 4 = 14$ are equivalent equations.

Solving Equations. To solve an equation is to find all the values of the unknown quantity which

will satisfy it. We proceed to solve an equation by finding an equivalent equation in which the value of the unknown will appear explicitly. For example, the equation $x + 2 = 7$ may be reduced to the equivalent equation $x = 5$ by subtracting 2 from each side of $x + 2 = 7$. The steps required in the reduction of a simple equation, such as the one above, to an equivalent equation depend upon the following four axioms:

1. If equals are added to equals, the results are equal.
2. If equals are subtracted from equals, the results are equal.
3. If equals are multiplied by equals, the results are equal.
4. If equals are divided by equals, the results are equal.

For example, to solve the equation $2x + 5 = 15$, we make use of axiom 2, subtracting 5 from each side to reduce it to the equivalent equation $2x = 10$. Then by axiom 4, we divide by 2, thus reducing it to the form $x = 5$, which is the solution.

Classification of Equations in One Unknown. Equations containing one unknown quantity may be classified according to the degree of the equation, that is, the highest power of the unknown quantity. According to this classification we have,

1. The linear equation, or the equation of the first degree, which can always be solved by means of the four axioms given above. Its general form is $ax + b = 0$.
2. The quadratic equation, or the equation of the second degree, whose general form is $ax^2 + bx + c = 0$. In order to solve this equation we need, in addition to the four axioms already given, the following axiom: (5) Like roots of equals are equal. The formula for the solution of the quadratic equation is

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

3. The cubic equation, or the equation of the third degree is one whose general form is

$$ax^3 + bx^2 + cx + d = 0.$$

The formula for the solution of the cubic equation is somewhat complicated and it is usually simpler to get the approximate roots by one of several methods of algebraic approximation or by the GRAPHICAL METHOD.

The classification of equations by their degree follows as indicated above. After the cubic equation comes the biquadratic, or fourth-degree equation; the quintic, or the equation of the fifth degree, and so on.

Certain forms of equations involve radicals, and a sixth axiom needed for their solution is (6) Equal powers of equals are equal. For example, if

$$\sqrt{x-2} = 10,$$

then by axiom (6), on squaring both sides

$$x - 2 = 100,$$

whence $x = 102$.

Simultaneous Equations. Two or more equations for which the number of unknowns is equal to the number of equations are called simultaneous equations. If the system of simultaneous equations is a linear system, we make use of the first four axioms in obtaining the solution. Thus in $ax + by + c = 0$ and $a'x + b'y + c' = 0$, we can eliminate one of the unknown quantities and thus obtain a single equation in the other unknown. For example, if $x + y = 7$, and $x - y = 3$, by addition we have $2x = 10$, whence $x = 5$. Since $x = 5$, $y = 2$, and the solution is thus obtained. The solution can also be obtained by the graphical method. Sometimes two linear equations in two unknowns have no common solution, as is the case with $3x + 4y = 7$ and $3x + 4y = 8$. Since the left sides of these equations are the same and the right sides different, it is evident that we have a contradiction. Such equations are said to be inconsistent. If the two equations of the system are equivalent, such as $x + y = 3$ and $2x + 2y = 6$, the system is said to be dependent. In this case there is in reality only one equation, that is, $x + y = 3$, which is an indeterminate equation. DETERMINANTS are very useful in solving linear systems of equations, especially when the system consists of three or more equations.

In general, two or more simultaneous quadratic equations cannot be solved by the methods of quadratics, but certain special types can often be solved by other methods. For example, the system $y - x^2 = 0$ and $x - y^2 = 0$ is readily solved by eliminating y , thus obtaining the biquadratic equation $x^4 - x = 0$. Factoring we have $x(x - 1)(x^2 + x + 1) = 0$, whence $x = 0$, $x = 1$, $x = -\frac{1}{2} \pm \frac{1}{2}\sqrt{-3}$ are the roots of $x^4 - x = 0$. Since $y = x^2$, we have the values $y = 0$, $y = 1$, $y = -\frac{1}{2} \mp \frac{1}{2}\sqrt{-3}$.

Practical Uses of Equations. The power of an equation as an instrument for solving any problem lies in the conciseness of the symbolic language which is used to express the condition of the problem. For example, if a boatman can row five miles down a river and back again to the starting point in two hours; and if the time rowing down is one-half the time rowing up, we can state the problem algebraically by letting $x =$ time down and $y =$ time up, expressed in hours, and we then have the two equations $x + y = 2$ and $y = 2x$, whence $x = \frac{2}{3}$ and $y = \frac{4}{3}$ is the solution.

G. W. M.

BIBLIOGRAPHY.—For a simple introduction to the subject, consult any textbook on elementary algebra. For a more advanced text, consult Dickson, *First Course in the Theory of Equations*, 1922.

EQUATOR, in geography, is that great circle marked on the surface of the earth by the intersection with a plane passing through the center and perpendicular to the axis of the earth. Extended indefinitely in all directions, this same plane marks on the celestial sphere a great circle which lies midway between the celestial poles and is called the CELESTIAL EQUATOR.

EQUATOR, CELESTIAL, the imaginary great circle drawn in the sky midway between the celestial

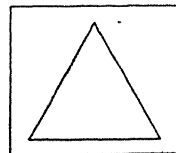
poles, or the intersection of the plane of the terrestrial equator with the celestial sphere.

EQUESTRIAN SCULPTURE, statues of celebrated persons mounted on horseback. The customary objects for portrait equestrian sculpture are royal personages, a tradition from the time when kings were military leaders and generals. Less frequent subjects are cowboys, hunters and early missionaries, men whose achievements were inseparably associated with horses. The majority of equestrian statues are cast in bronze. One authority estimates that there are close to 700 equestrian statues in the world, of which the United States has approximately 100. Germany with close to 200 has more than any other one country.

It is not known when the equestrian type of statue first appeared. Lysippus in the 4th century B.C. made many equestrian statues of Alexander and his generals, indicating that this type was common in the great period of Greek sculpture. An equestrian statue of Nero found at Pompeii dates from about 65 A.D., and one of Marcus Aurelius on the Capitoline Hill, Rome, dates from the 2nd century. The finest equestrian statue in the world is of Gen. Bartolommeo Colleoni. It was modeled by Verrocchio, a pupil of Leonardo da Vinci. The original of the statue stands in front of St. Mark's in Venice; a copy is in Lincoln Park, Chicago.

A lead statue of George III, mounted, was perhaps the first erected in North America. It was made in London by Wilton and set up in Bowling Green, New York City, in 1770. It was torn down by an angry mob after the reading of the Declaration of Independence on July 9, 1776 and made into 42,000 bullets for the Continental Army. Only the horse's tail survived. It is carefully preserved in the Museum of the New York Historical Society. Washington, D.C., has 15 equestrian statues. The majority are of generals, three are of presidents, one of Joan D'Arc and one of Frederick the Great.

EQUILATERAL TRIANGLE, a triangle having its three sides all equal. Among its properties are the two that (1) its angles are all equal, (2) the bisectors of its angles and the perpendicular bisectors of its sides all meet in the same point. See TRIANGLE.



EQUILATERAL TRIANGLE

EQUINOX, the two intersection points of the celestial equator and the ecliptic. The sun reaches the vernal equinox about March 21, of each year, the autumnal equinox about September 23. On these dates the length of day and night is the same all over the earth, from which fact the equinoxes derive their name.

EQUISETITES, a group of mighty fossil plants of which a diminished representative is found in the little scouring-rush, or horsetail (*Equisetum*) of to-day. This exemplifies the survival without essential modification of a very ancient race. Beginning in the Devonian, the Equisetites reached their culmination in

the giant tree-horsetails or CALAMITES of the Coal Measures. They were characterized by hollow stems, ribbed and jointed, whorled branches, and reduced leaves sheathing the joints. The conelike fruit borne at the end of the branches contained but one kind of spores. In the Mesozoic the group was represented by forms intermediate in size between the huge Calamites and living species, the largest of which is 30 ft. tall with stems an inch thick. Knowlton cites a fossil horsetail from the Triassic of northern Mexico with stems or trunks 4 or 5 in. in diameter, which "seemingly cannot be distinguished from the true Equisetum."

EQUITES, originally the wealthiest part of the Roman people who furnished the cavalry in war; later the middle class who became very important politically as a result of their wealth amassed through commerce from which the senators were debarred. From the time of C. GRACCHUS (123 B.C.) to SULLA (81 B.C.) they formed the jurors in the courts; after the fall of Sulla they were reinstated in varying degrees at different times. Under the empire they became close adherents of the throne, and powerful officials.

EQUITY, a system of remedial justice administered by the Court of Chancery in England, and by Courts of Chancery or of Equity in the United States by derivation from England. As the common law developed in the King's courts in a period of strict law, form came to prevail over substance and the moral aspects of conduct and of transactions were ignored. Also the system of legal remedies was hard and inflexible and did not permit of dealing with many situations in such a way as to promote justice. From an early time, where justice could not be had in the ordinary courts, application was made to the King for special relief. The Chancellor was, as it were, the King's private secretary, and petitions for relief of this sort more and more came to him and were disposed of by him. In this way the Court of Chancery grew up, and through its experience of deciding causes and granting extraordinary relief a system of equity was developed. By the end of the eighteenth century the lines of jurisdiction of the Court of Chancery had been thoroughly fixed and the principles of exercise of that jurisdiction determined. In part the systematization of equity went on concurrently in the United States in the latter part of the eighteenth century and the fore part of the nineteenth century. Early in the nineteenth century it was possible for a great Chancellor to say that the doctrines of the Court of Chancery "ought to be as well settled and made as uniform almost as those of the common law, laying down fixed principles, but taking care that they are to be applied according to the circumstances of each case." In the United States the federal courts from the beginning administered both law and equity. At least from the middle of the nineteenth century this came to be true of a majority of the states. To-day with few exceptions law and equity are administered in the same tribunal and in the same proceeding.

EQUITY, BILL IN. See BILL IN EQUITY.

EQUULEUS (gen. *Equulei*), the filly, a small constellation between Pegasus and Aquila. See STAR: map.

ERA OF GOOD FEELING, a name somewhat inaccurately applied to the administration of President Monroe (1817-25), which was characterized by the disappearance of partisan divisions. The FEDERALIST party dissolved after the election of 1816. The surviving Republican party (see DEMOCRATIC-REPUBLICAN PARTY) had to some extent absorbed Federalist views. In 1820 Monroe received every electoral vote except that of William Plumer of New Hampshire, an aged ex-Federalist who wished that Washington alone should have the honor of unanimous election to the presidency. Beneath this apparent quiescence, however, personal factions had developed. Voters were grouped about the several party leaders, rival Republican aspirants for the presidency.

ERASISTRATUS (310-250 B.C.). Alexandrian anatomist, was born at Chios. He established a school of anatomy at Alexandria and was the first experimental physiologist. He made important investigations concerning the nervous system; he showed the relations of the larger nerves to the brain and spinal cord. Erasistratus described various valves in the heart. He almost conceived the mystery of the circulation, but he had concluded it backwards, believing that the heart was a pump which forced the blood from the liver by the arteries to the heart and then to the lungs by the veins. Anatomists credit him also with considerable knowledge of the convolutions of the brain, the naming of the trachea and the invention of a catheter.

ERASMUS, DESIDERIUS (c. 1466-1536), Dutch scholar and theologian of the Renaissance, was born at Rotterdam, probably on Oct. 28, 1466, an illegitimate son of one Gerhard of Gouda. He received his early education from the priests of Utrecht, where he was a choir-boy in the cathedral until the age of nine. He spent the next 5 years at the celebrated religious school of Deventer, Holland, and obtained the best education then available. His scholarly bearing was remarked even at 17, when he entered an Augustinian monastery near Gouda, and his instructors and friends predicted that Erasmus "would be the most learned man of his time." In 1492 he was ordained, and went to Paris for additional studies in theology and to acquaint himself with contemporary letters. Meanwhile he made a living by tutoring wealthy Englishmen; one of them, Lord Mountjoy, gave Erasmus a life pension. As an independent scholar he accompanied Mountjoy to London in 1497, and was presented and well liked at court. Erasmus spent the next 10 years in travel, and while in Italy he obtained from the Pope release from his vows. During 1502-04 he taught at the University of Louvain, but mindful of his friendly reception in England, he left the Continent and in 1506 arrived a second time at London. At this juncture he met SIR THOMAS MORE, the Lord Chancellor, who, de-

lighted with the newcomer's discourse but ignorant of his identity, exclaimed, "You are either Erasmus or the devil." He taught theology and Greek for brief periods at Oxford and Cambridge, and then returned to the Continent with the intention of reviving "theology, the queen of the sciences." He settled at Basel, Switzerland, in 1513, becoming general advisor to the printing house of Johann Froben. Erasmus was soon the center of the most scholarly theological group in Europe, and his works thenceforth, coupled with the evangelical labors of MARTIN LUTHER in Germany, prepared the way for the REFORMATION. He now launched successive attacks on religious ignorance and superstition, and although he called himself a Catholic, his scorn was often directed at clerical abuses. His most celebrated work, published first in 1516, was the Greek translation of the Bible, which showed that the Vulgate version used by the Church was erroneous in many passages. His remaining works include *Encomium Moriae* and the *Colloquies*. Erasmus died at Basel, July 12, 1536.

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ERATO, one of the nine MUSES.

ERATOSTHENES (c. 276 B.C.-c. 196 B.C.), Greek astronomer and geographer who worked at Alexandria, Egypt. Eratosthenes found that at noon on midsummer day the sun cast no shadow at Syene, Aswan, at the first cataract of the Nile, while at Alexandria, which he supposed to be due north of Syene, the sun cast a shadow equal to 1/50th of the whole meridian circle; assuming that the rays of the sun at Syene and Alexandria are parallel, and that the distance between the two cities is 5,000 stadia, Eratosthenes concluded that the total circumference of the earth was 50 times 5,000 stadia. As the stadion of Eratosthenes is held to have been 157.5 meters, or 616.73 feet, this will give the circumference of the earth as 24,662 miles, and its diameter as 7,850 miles, or only 50 miles less than the true polar diameter of the earth. Eratosthenes also tried to measure the distance of the sun and moon from the earth. He thought that the sun was more than 1,000 times more distant than the moon, but fell far short of the true distances. His approximately correct estimate of the circumference of the earth was accepted by astronomers and geographers in later centuries, and served as the basis for the calculations of Christopher Columbus. He died about 196 B.C.

ERBIUM, a metallic chemical element, symbol is Er, its atomic weight 167.64, belonging to the rare earths, and occurring in the minerals gadolinite and euxenite. Solutions of its salts have a pronounced pink color and show a strong absorption spectrum.

ERCILLA Y ZÚNIGA, ALONSO DE (1533-94), Spanish poet, was born at Madrid, Aug. 7, 1533. He was page to Philip II at his wedding with "Bloody Mary." Sailing for Chile in 1554, he made his mark in the campaign against the Araucanos. Following a brawl, he was condemned to death, but was re-

prieved on the scaffold and exiled to Callao. He returned to Europe in 1562, bringing with him his poem *Araucana*, 1533, the first important literary work composed on either American continent. *Ercilla y Zúñiga* died Nov. 29, 1594.

ERDELYI, JANOS (1814-68), Hungarian lyric poet and authority on folklore, was born at Kapos, Apr. 1, 1814. He directed the National Theatre at Pest, 1848, and later was appointed Professor of Philosophy at the University of Sarospatak. His *Poems*, 1844, show considerable technical excellence and lyric emotion, but his reputation rests chiefly on the numerous collections he published of Hungarian national songs and folklore and his collection of more than 7,000 Hungarian proverbs. He is also the author of many important critical and esthetic studies. Erdelyi died at Sarospatak, Jan. 23, 1868.

EREBUS, in Greek mythology, son of Chaos and father of Aether, or the upper air, and of Hemera, or day. Nyx or night was his sister and wife. The word means complete darkness and was applied to the region through which the souls of the departed went to Hades. The dog CERBERUS dwelt there to guard the entrances of Hades.

ERECHTHEUM, one of the buildings on the ACROPOLIS of Athens, devoted to the worship of Erechtheus, said to have been a king of Athens, and sacred also to Poseidon, Zeus, and Athena. The asymmetrical plan, unique in Greek architecture, indicates this multiple function; the Erechtheum is really a group of temples, on different levels and with separate entrances. It was begun in 431 or 421 B.C. and some authorities claim it was never completed. Others state it was completed in 407 B.C. The north portico is considered the finest example known of the Ionic style; the south porch is supported by the famous Caryatides. The perfection and delicacy of the detailed carving on the Erechtheum marks one of the high points in the history of ornament.

ERFURT, a city in the Prussian Province of Saxony, just off the northern edge of Thuringia, about 68 mi. southwest of Leipzig. Three branches of the Gera River flow through it and its many towers make the old inner city attractive and interesting. Noteworthy churches are the cathedral, 1154-1450, and the churches of the three mendicant orders, especially the Augustinian, where Luther was in 1505-08. The secular buildings are mostly in Renaissance and Baroque style. Shoes, metals, machines and clothing are manufactured, and the city is an important trading center. Pop. 1925, 135,579.

ERG. See WORK.

ERGOT, a highly poisonous black body sometimes found replacing the grain in the heads of rye and other cereals. This body is produced by the growth of a fungus (*Claviceps purpurea*) within the developing grain. Ergot contains powerful alkaloids, preparations of which are used in medicine to stimulate muscular contractions of the uterus.

ERICSSON, JOHN (1803-89), Swedish-American engineer and inventor, was born at Fernebo, in Werm-

land, July 31, 1803. He studied military engineering and served for a time in the Swedish army, but resigned to give all his time to inventing machinery. He went to England, where he won a prize for the best locomotive engine. While in England he built the first steamer propelled by a screw instead of by paddle wheels. He came to the United States in 1839 and was employed by the Government to build a war vessel with a screw propeller. When the Civil War broke out he designed for the Federal Government a war vessel with guns mounted in a revolving turret. The first vessel of this type was the Monitor, which defeated the Confederate ironclad, Merrimac, in the historic battle off Hampton Roads on Mar. 9, 1862. He died at New York, Mar. 8, 1889.

ERICSSON, LEIF (c. 975-c.1010), Scandinavian explorer and discoverer of "Vineland" in North America, was born in the last quarter of the tenth century, the son of the famous **ERIC THE RED**. Starting out from his father's Greenland settlement in 999 Leif went on a visit to King Olaf of Norway by way of the Hebrides. On his return trip Leif encountered a severe storm and finally came to port in the harbor of a strange land which may have been Labrador or Nova Scotia. Leif called this new land Vineland because of its abundant grapes and returned to Greenland with the tale of his discovery. Little else is known of his life, but the details of his adventures may be found recorded in the famous *Saga of Eric the Red*.

ERIC THE RED (c. 950-c.1000), Norse explorer and founder of the first settlement in Greenland, was born in Iceland in the latter half of the tenth century. His father had settled in Iceland many years before, and the tradition is that Eric and his men were outlawed from Iceland for manslaughter, and, sailing westward, discovered Greenland in 982 and explored the west coast for a period of three years. Eric the Red returned to Iceland for more men and in 986 founded a settlement in Greenland. The settlement was located in the present Julianehaab district in southwest Greenland. Little is known of Eric's later life, but his son, **LEIF ERICSSON**, is the famous Viking who is said to have discovered North America about 1000 A.D.

ERIDANUS (gen. *Eridani*), the mythological river, the longest constellation in the sky. It begins near Rigel, with the third and fourth magnitude stars Beta and Lambda, first flows westward as far as Cetus, then eastward again, then southward, finally ending far in the south, with the first magnitude star **ACHERNAR**, meaning river's end in Arabic.

The constellation is rich in interesting objects. The adjacent stars Delta and Epsilon are both near to us, being 23 and 10 light years distant, respectively, while ρ Eridani, a double star of the fifth magnitude near Achernar, is 21 light years away. Delta is about equal to the sun in brightness; Epsilon and the components of ρ 5 to 16 times fainter. The fourth magnitude star α_2 Eridani, 16 light years distant, is triple and consists of a yellow, a white, and a red star, which are

3,300 and 1,000 times fainter than the sun respectively. The last two revolve around each other in 248 years at a distance of 320 million miles. The white star is a **WHITE DWARF** whose density is probably 64,000 times greater than that of water. See **STAR: map**.

ERIE, a tribe of the Iroquoian linguistic stock occupying, in the 17th century, the lands from Lake Erie southward to the Ohio, and eastward to the Allegheny and the Genesee rivers, where their territory adjoined that of the Conestoga and the Seneca. At their northern boundary, probably the end of Lake Erie, their neighbor was the Neutral Nation. Their population in the 17th century is estimated at 15,000. Though not well known culturally or linguistically they appear to have been like the **HURON**. They were composed of several sedentary divisions, lived in villages, were agriculturists, and had many warring encounters with the Iroquois Confederacy, which in 1656 were concluded by their surrender to the Onondaga. Some of the so-called Seneca now living in Oklahoma are regarded as most probably descendants of the Erie.

ERIE, a port city in northwestern Pennsylvania, the county seat of Erie Co. It is situated on Lake Erie, 147 mi. north of Pittsburgh. Airplanes, steamships, bus and truck lines and several railroads serve the city. Erie has a large factory output, worth about \$101,000,000 in 1929. The chief manufactures are electrical goods, steel and iron products, asbestos, silk, paper and many other commodities. The wholesale trade proper amounted to \$19,939,305 in 1929 and the retail business to \$59,233,690. The well protected natural harbor has a large traffic in pulpwood, grain, flour, iron ore and coal. Its total imports and exports were worth \$38,052,478 in 1929. The city is the seat of the state fish hatchery, weather bureau, the Erie Branch of the University of Pittsburgh, and a branch of the Edinboro State Normal School. Erie was founded by Seth Reed in 1795. It became a city in 1851. Pop. 1920, 93,372; 1930, 115,967.

ERIE, LAKE, one of the five Great Lakes in east central North America. It lies across the boundary separating the United States from Canada, between 78° 50' and 83° 30' W. long. and extends from 41° 23' to 42° 53' N. lat. The province of Ontario bounds it on the north and the states of Michigan, Ohio, Pennsylvania and New York surround its other sides. Lake Erie is the shallowest and the second smallest of the lakes. Its water surface is 9,940 sq. mi., 4,990 of which lie within United States territory and its mean depth is only 70 ft. The maximum depth is 210 ft. which is considerably above sea level as the mean elevation of the water is 572.43 ft. This level is 8.51 ft. lower than Lake Huron which empties into Erie through the Detroit River, and 326.32 ft. higher than Ontario into which Erie drains by way of Niagara River and Niagara Falls. Its greatest length is 241 mi. and greatest width 57 mi. The coastline is regular throughout its length of 657 mi. and the drainage basin of 34,680 sq. mi. covers a

densely populated, highly cultivated region including 23,570 sq. mi. within the United States.

All the cargoes enroute to the Atlantic seaboard from the three large upper lakes cross Erie where they have two outgoing channels. The Welland Canal built parallel to the Niagara River, leads into Lake Ontario and thence to the St. Lawrence River; and the Erie Canal, extending from Buffalo, N.Y., to Troy on the Hudson River, creates a continuous waterway from Lake Erie to the New York harbor. The traffic on these two canals for 1929 was 2,876,160 tons for Erie and 4,769,866 tons for Welland.

Lake Erie has some of the largest and most important ports on the Great Lakes including Detroit, Toledo, Sandusky, Cleveland, Ashtabula, Lorain, Fairport, Conneaut, Erie and Buffalo. Many of these are manufacturing cities using the ores and metals from the mines in the upper lakes country. In 1929 the harbor at Cleveland cleared 16,838,712 tons of freight, three-fourths of which were ores and metal manufactures; and the bulk of the cargoes handled at Ashtabula and Conneaut were of the same character. Toledo and Sandusky handled mostly coal, limestone, sand and gravel, and Buffalo was the destination of millions of bushels of wheat. The navigation season extends from around the first of April to the middle of December. Erie was the last of the Great Lakes to be discovered. Joliet, a French explorer, visited it first, in 1669, when hunting for copper deposits.

ERIE CANAL, a canal connecting Buffalo on the Great Lakes with Albany on the Hudson River. It is the second longest canal in the world.

Surveys for a canal to connect Lake Ontario and the Hudson were made in the Mohawk valley as early as 1784 and 1791. In 1792, largely through the efforts of Gov. De Witt Clinton, the Webster Island Canal Company was formed and six miles of canal was built at Little Falls, permitting traffic on the upper Mohawk River. In 1816 Clinton was made head of a commission to build a canal from Buffalo to the Hudson and ground was broken at Rome, N.Y. on July 4 of that year. In Oct. 1819 the Rome-Utica section was opened and by the next year the canal had reached Seneca Lake. On Oct. 26, 1825, the first boat, the *Seneca Chief*, left Buffalo for New York. The original canal could take boats 80 ft. long and 15 ft. wide with a draft of 3½ ft. In 1835 it was enlarged and again in 1849. By 1853 barges of 200 tons displacement could use the canal. In 1862 the canal had been widened to 70 ft. at the top and 52 ft. at the bottom and the depth increased to 7 ft. permitting barges weighing 240 tons and carrying 8,000 bu. of wheat to pass. See NEW YORK STATE BARGE CANAL SYSTEM.

ERIGENA, JOHANNES SCOTUS (9th century), philosopher and theologian, was born in Ireland in the early 9th century. Little is shown of his life except for the period of about 847-876 when he was at the court of Charles the Bald. Here he was head of the palace school and spent much time in making translations. His translation of the writings

of the pseudo-Dionysius was attacked by Pope Nicholas I, and his theological views were condemned at the Synod of Valence in 855 and at the Synod of Langres in 859. His most important work was *De Divisione Naturæ*, written about 870. He died about 890.

See H. Bett, *Johannes Scotus Erigena*, 1925.

ERIKSSON, MAGNUS (1316-80), 1st King of united Sweden and Norway, son of the Swedish royal duke Eric and of the Norwegian princess Ingeborg was born in Sweden in 1316. At the early age of three Magnus inherited the throne of Norway from his grandfather Haakon V and reigned as Magnus VII of Norway. In the same year he was elected King of Sweden at the Convention of Oslo. In 1343, Magnus resigned the Kingdom of Norway to his son Haakon VI, and in 1359 he summoned the first Swedish Riksdag in which the townsmen as well as the nobles and clergy were represented. In 1365 his nephew, Albert of Mecklenburg, was elected King of Sweden. Magnus died in 1380.

ERIN, the ancient name for Ireland, which legend says was named after Eire, wife of MacColl, one of the early kings of the Dedannans ruling in that country at the time of the coming of the Milesians or Scots. Erin is the dative case of Eriu from the middle Irish Heriu; Heriu is probably a contraction of a longer form written Ivernia in Greek and Iberio, Hiberio or HIBERNIA in Latin.

ERINNA (c. 600 B.C.), Greek poetess, was born in the 6th century B.C., on the Island of Lesbos. She is said to have been a friend of SAPPHO, but may have lived in the early Alexandrian period. Her poems were written in a mixture of Doric and Aeolic dialects. Only fragments remain, of which the best known is *The Distaff*. The Greeks thought her poems equal to Homer's. Erinna died at 19 years of age.

ERINYES, in Greek mythology, goddesses of vengeance and punishers of crime, identified with the Furies or EUMENIDES. They have been confused also with the FATES.

ERIS, in Greek mythology, the goddess of strife, the same as the Roman DISCORDIA. Some writers make her the personification of rivalry without discord.

ERITREA, an Italian colony in Africa between the Red Sea and Abyssinia. Area with the Dahlak islands, 45,754 sq. mi.; the coast line extends for about 670 mi. Pop. 1921, 402,793, exclusive of 4,681 Europeans, mostly Italians. The Hamitic tribes that form the bulk of the population are chiefly nomadic. The colony is divided into eight administrative divisions. The most densely populated is that of Hamasien, which contains the capital Asmara, 7,700 ft. above sea level. The low sandy coast is backed by high land except in its central part. That portion of the area which curves round the north of Abyssinia contains the upper Baraka, flowing into the Sudan. The coast, receiving about 7 in. of rain chiefly in winter, is hot and arid, but the highlands are more tem-

perate and are brought a fair amount of summer monsoon rain.

The vegetation varies from semi-desert to savanna and forest growths, and pasture generally exists. There are about 1,750,000 sheep and goats, 70,000 camels and more than 500,000 cattle. Donkeys, mules, oxen and camels are widely used for transport. The streams that come from the highlands are being utilized for irrigation which particularly affects cotton raising. Prospecting for minerals is carried on in the region and gold is worked in the neighborhood of the capital. Potash is exploited farther south, and petroleum has been found. Pearling in the Dahlak archipelago is an important industry.

The district is not regarded as attractive to Italian settlers, but there is a growing colony near Massawa, Eritrea's chief port, located on a small island connected with the mainland by a causeway. Here a new town, Vittorio d'Africa, has been established. The capital is at Asmara, pop. 18,500. In 1890 the Italian possessions on the west coast of the Red Sea were united to form the present colony.

ERIVAN, capital of the Armenian S.S.R., near the Turkish border in southwestern Russia, and the termination of an express railway from Moscow through TIFLIS, 230 mi. north. On the river Zanga, it lies in a broad valley, surrounded by hills, at an altitude of 1,042 ft. The preponderantly Armenian population engages in the cultivation of grapes, fruits and melons. Local plants make wines, glycerine and other commodities. Since the 7th century Erivan has undergone the domination of Arabs, Persians and Turks; Russian rule began in 1827. Parts of an old fort, built during the 16th and 17th centuries by Turks and Persians, still remain and within its walls are the ruins of ancient buildings. The capital is the cultural center of Soviet Armenia, with such institutions as the State University, the Armenian State Museum, the Tropical Institute, large public libraries, a meteorological station and experimental farms. A handsome relic of earlier days is the richly tiled Gei Mosque. The town divides into an old section, with crooked, narrow lanes, and a modern, rapidly improving community. Pop. 1926, 64,649.

ERLANGEN, a city of Bavaria, situated on a fruitful plain about 15 mi. north of Nuremberg. The inner city has the aspect of a little capital, due to the many Baroque houses and, particularly, the former palace of the margraves, now part of the university. North and south are modern suburbs manufacturing leather, cloth, paper and gloves. The Bishop of Wurzburg possessed the city from 976, the Bishop of Bamberg since the 11th century; later it went to Bohemia, to the Hohenzollerns, and to France, and finally to Bavaria. Pop. 1925, 29,343.

ERLKING or **ERLKÖNIG**, in German mythology, a mischievous weird spirit, king of the elves. The Erlking, usually portrayed as living in the Black Forest, lured people, and especially children, to their destruction, as is told in Goethe's ballad, *Der Erlkönig*.

ERMINE (*Putorius ermineus*), a member of the weasel family, known as the stoat in England, the name ermine applying only when the brown summer coat is replaced by the white winter coat. The ermine's tail-tip is always black. Like all weasels, the ermine is extremely bloodthirsty. It attacks and kills animals larger than itself, living on squirrels, rabbits and birds. Its slender body is about 10 in. long, the tail 4 in. From four to six young are born in late spring. The valuable fur was, in the Middle Ages, restricted to royalty. The whitest and therefore the most highly prized skins come from Siberia.

ERMINE STREET, one of the four great roads of early Britain. It ran north from London through Huntingdonshire to Lincoln, in some places following an old Roman road. The exact age of these roads is not known, but they were in existence in Saxon times, and the greater part of them were built by the Romans. See also **WATLING STREET**.

ERNANI, an opera in four acts by GIUSEPPE VERDI, libretto based on VICTOR HUGO's *Hernani* by Francesco Maria Piave; première, Venice, 1844, London, 1845, New York, 1846. The first of Verdi's operas to gain a secure place in the standard repertory, it falls considerably below the standard of the long series he composed during the next half century.

Ernani, otherwise John of Aragon, son of the slain Duke of Segovia, has become a bandit, pursued by the king of Castile, Don Carlos. He has fallen in love with Donna Elvira who returns his love although she is betrothed to an aged Spanish grandee, Ruy Gomez di Silva. Also in love with her is Don Carlos, the king, who later is to become the Emperor Charles V. Learning that a young cavalier has nightly access to the lady's chambers, the king imitates his signals and secures admission to Elvira's presence, whereupon he announces his own love. Ernani, already on the scene, now steps from hiding, and a violent altercation immediately develops. At this juncture Di Silva enters. He at first challenges both, but upon learning that one of them is the king he apologizes. For his part Ernani refuses to fight Di Silva, reminding him that the king is their common rival. Accordingly they conspire to murder Don Carlos, and let Di Silva's revenge on Ernani be executed, if at all, at a later moment. Since the king has already borne off Elvira as a hostage, Di Silva agrees to this arrangement, taking Ernani's silver hunting-horn which is offered as a pledge by the bandit; the former has only to blow it and the life of the latter will be placed in his power. But the king has learned of the conspiracy, and both conspirators are caught and condemned to death. Pleading that he be allowed to die in a manner appropriate to his rank, Ernani reveals his identity as John of Aragon. In view of this fact, and at the intervention of Elvira, both conspirators are pardoned by the new emperor. Without more delay the nuptials of Ernani and Elvira are made ready; but at the crucial moment Di Silva sounds the pledged hunting-horn, and

Ernani, given only the choice of poison and a dagger, chooses the latter. Upon his dying body Elvira prostrates herself as the avenger Di Silva stands over them both.

EROS, the Greek god of love, generally described as a son of **APHRODITE**. His influence pervaded all life. He tamed lions and tigers, broke the thunderbolts of **ZEUS** and played games with the monsters of the sea. From his name there is derived the adjective erotic. *See* **CUPID**.



EROS, THE GOD OF LOVE
From a design in the Louvre
Museum, Paris

EROS, one of the **ASTEROIDS**, or small planets, discovered in 1898, revolving around the sun in 643 days at a mean distance of 135 million miles. Its orbit lies partly inside that of the planet Mars. It derives its special importance from the

fact that it may come as close to us as 14 million miles, nearer than any other body except the moon.

EROSION, the geological process whereby the lands are continually being worn away, and which would eventually reduce them all to approximate sea-level were there no process of upbuilding. The term is often used to include **WEATHERING**, but usually is confined to the mechanical action of water, ice, the atmosphere and organic agencies.

Most important of these is the power of running water. Rain falling on rock surfaces already partially decomposed and disintegrated by weathering, detaches particles which are washed into rivulets, streams and rivers. This load of suspended matter provides the flowing water with a powerful abrading agent, acting like sandpaper in grinding away the rocky beds of the streams and wearing away their banks. More violent is the hammering action of waves on the sea shore, which grind the rocks, producing sand and silt. Rock disintegration is aided in cold climates by the freezing of water in the pores between the mineral constituents. All rocks contain some moisture and, as it expands on freezing, this powerful prying action quickly reduces the rock to sand. The expansion and contraction of rock surfaces exposed to rapidly changing temperatures causes a scaling off of fragments, or spalling. Wind-blown sand also wears away exposed rocks.

In polar regions and high mountains where glaciers exist, stones and sand frozen in the bottom of the moving ice powerfully abrade underlying bed rock, scarring it and grinding it to powder.

Mosses and lichens growing on bare rocks send rootlets into every interstice, and roots of larger plants take advantage of cracks and crevices, aiding the break-up of the rock.

The sum total of these actions is to provide rivers with a tremendous load of sediment. It has been estimated that the Mississippi River annually carries 500,000,000 tons of earth to the sea, and that North

America might thus be reduced to sea level in 4 to 5 million years. Erosion by running water has produced such features as the Grand Canyon. The same process can be seen in operation in any roadside gully. *See also* **DEPOSITS**; **GEOLOGY**; **GLACIATION**; **SEDIMENTATION**.

S. F. K.

Erosion of Soil, by wind, ice or by water principally, is the cause of gulleying and serious loss of top soil and impoverishment of land in many locations. Deforestation, removal of protective vegetation through excessive grazing, and other improper agricultural practices, contribute to harmful erosion.

Protective measures lie principally in reforestation, planting, and restoration of vegetation where practicable, and retarding of velocity of flow of storm water. Flow of water is artificially retarded by making furrows and ditches of low rate of fall, "retards" to flow in ditches, terracing of land, mud fences, hedges, and the like.

Erosion of Coasts is due to the normal action of waves and currents, and to abnormal conditions during storms. Friable coasts are subject to constant change, wave action setting material in motion and causing it to move up and down the beach and the current causing drift along the shore, the resultant being a zig-zag movement of the material on the shore. Shore configuration and other factors cause the cutting away of the shore at some locations; the material being carried into deep water or even deposited further along shore.

Erosion of banks of streams is due to stream currents of velocity swift enough to scour away land; and to wave action in some cases, though generally to a lesser degree. In streams scouring is generally greatest on the outside of bends where the current is swiftest and where it "sets in" towards the bank. The material removed is deposited at points of lower velocity—on the insides of bends, at widenings, or at sea. The cutting of the outside of bends and depositing on the inside accounts for the tendency of streams to "meander." In tidal streams conditions are more complex, often resulting in variable and multiple channels, and shifting bars.

In navigable canals with negligible flow, particularly those of relatively small cross section, the wave action due to passing boats may seriously erode the banks. *See also* **SEA WALLS**; **RIVER IMPROVEMENT**.

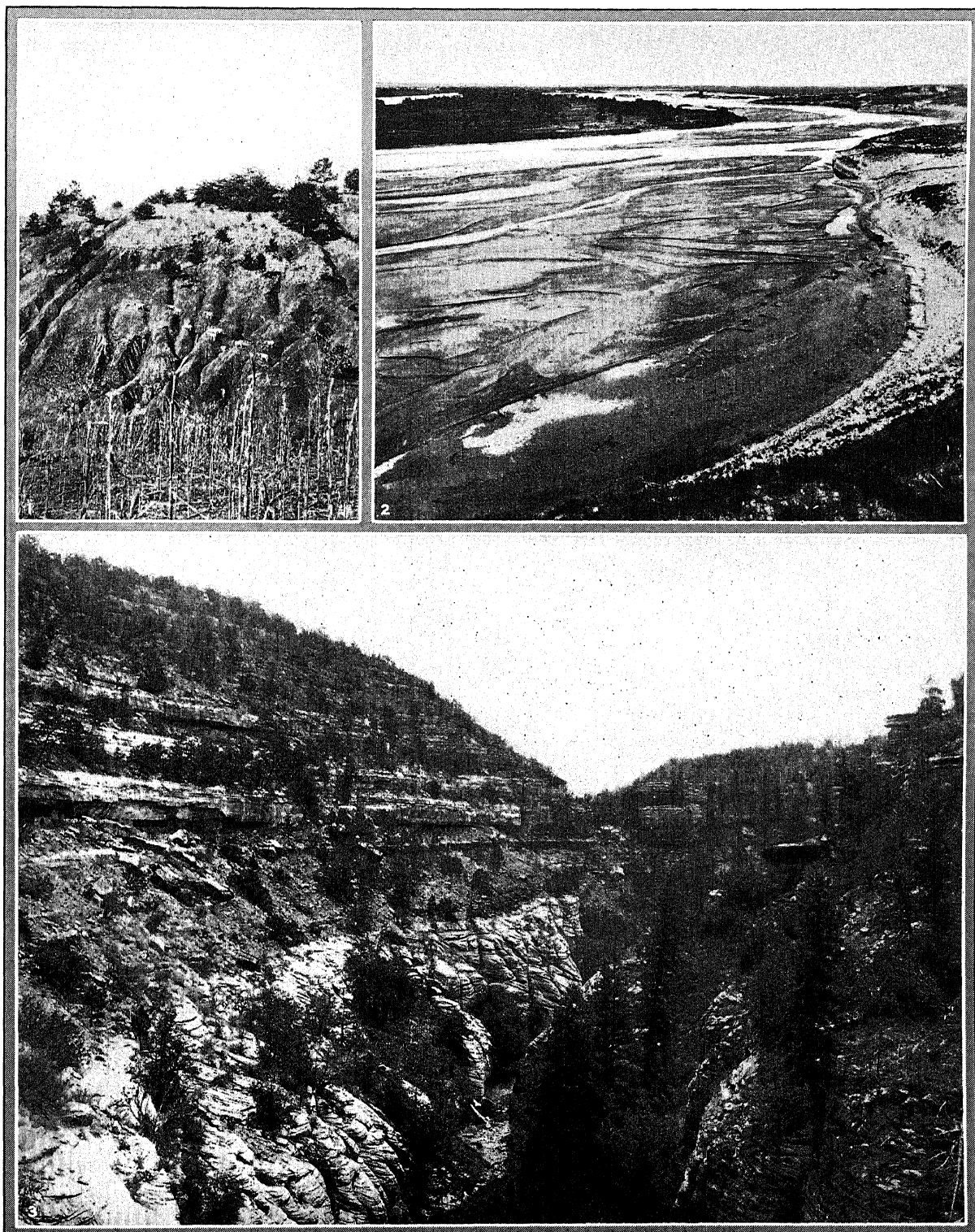
F. R. H.

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ERROR, the difference between an observed or calculated value and the true value. *See* **PROBABILITY** AND **ERROR**.

ERSKINE, JOHN (1879-), American writer, was born in New York City, Oct. 5, 1879. He received his Ph.D. degree at Columbia University in 1903. From 1903 to 1909 he taught English at Amherst College. He has since taught at Columbia, and been prominent in educational and musical work in

EROSION



COURTESY UNITED STATES GEOLOGICAL SURVEY

TYPICAL EXAMPLES OF EROSION

1. Erosion of a hillside into gullies by the force of running water. 2. A stream (North Platte River, Western United States) building up its bed with material, derived from erosion, from upstream. Slackening velocity causes this material to be deposited in the lower reaches of the river's

course. 3. A steep-walled canyon, or "young" valley (Walnut Canyon, Arizona), cut in flat-lying, sedimentary rocks. The stream visible at the bottom of the valley has eroded its bed downwards, but weathering has worn the walls back but slowly, producing a steep-sided valley.

the city. In 1925 Erskine published his popular success, *The Private Life of Helen of Troy*. It was followed by *Galahad*, 1926, *Adam and Eve*, 1927, *Penelope's Man*, 1928, *Sincerity*, 1929, *Uncle Sam in the Eyes of His Family*, 1930, and *Peter Kills the Bear*, 1931.

ERSKINE, THOMAS, 1st baron (1750-1823), English barrister, was born at Edinburgh, Jan. 10, 1750, youngest son of the tenth Earl of Buchan. He entered the navy as midshipman but later joined the army. In 1775 he gave up the military for the law profession, and was admitted to the bar three years later. He sold his commission in 1775, entered Lincoln's Inn, and was called to the bar in 1778. Among his clients were Admiral Keppel and THOMAS PAINE, when prosecuted in 1792 for the publication of the *Rights of Man*. His great contribution to the cause of personal liberty was his attacks on the theory of constructive treason. He was not a success in Parliament, to which he was elected in 1783, nor as chancellor, a post he held in 1806-07. He died at Almondell, Lulithgowline, Nov. 17, 1823.

ERVINE, ST. JOHN GREER (1883-), Irish dramatist and critic, was born in Belfast, Dec. 28, 1883. His first successful play, *Mixed Marriage*, was produced by the Abbey Theatre, Dublin, in 1911. Other plays were *Magnanimous Lover*, *Jane Clegg*, *The Critics*, *The Orangeman*, *John Ferguson*, *The Island of Saints*, *The Wonderful Visit*, with H. G. Wells; *Mary, Mary, Quite Contrary*, *The Lady of Belmont*, *Anthony and Anna*, *Old George Comes to Tea*, *She was No Lady*, *The First Mrs. Fraser*. During the World War Ervine served with the Royal Dublin Fusiliers. He has been dramatic critic for several prominent newspapers, including the *New York World*.

ERYNGO, a genus (*Eryngium*) of coarse plants of the parsley family, known also as sea holly, several of which are grown as ornamentals. There are about 220 species of wide distribution in tropical and temperate regions, some 25 occurring in North America. They are mostly annual or perennial herbs, often with a bluish or purplish cast of herbage, bearing rigid, spiny-margined leaves and small white, greenish or blue flowers in teasel-like heads.

ERYSIPELAS, a disease in which there is a streptococcus infection of the deep layers of the skin, the face being most often affected. The disease is somewhat communicable, and is a rather frequent disorder, especially during middle age. While in itself erysipelas is only moderately serious, it may easily prove fatal when it occurs in old people or in those who have been weakened by previous disease.

The condition starts with redness and swelling of the skin, the area affected gradually increasing in extent. There is no pus formation. The fever may be high, and continue for about a week. At the end of that time, the temperature usually drops, and the swelling and redness disappear. There are usually no complications.

In the treatment, various local applications, such as

application of Epsom salts solution, are advised which may afford some comfort but which have no specific influence on the course of the disease. Serum treatment has recently been advocated, but its value has not as yet been definitely established. Generally, the natural forces of the body may be relied upon to bring about recovery.

An individual with erysipelas should always be isolated, and the isolation should be maintained until peeling takes place over the affected area. W. I. F.

ERZURUM or **ERZERUM**, capital of the vilayet of Erzurum and one of the chief cities of Asiatic Turkey, located at the end of a plain near the Kara-Su River. High, rocky mountains, the streams of which furnish the city with water through a system of wooden pipes, surround the plain. Volcanic stone is the building material of Erzurum's flat-roofed houses which are crowded together. Numerous baths, mausoleums and mosques, however, relieve the monotony of the view.

Originally named Garin Khalikh, Erzurum fell to the Seljuk Turks in 1201, and to the Mongols in 1242. The Osmanli Turks captured the city in 1517. At the close of the Russo-Turkish War in 1877-78, the Russians who had occupied it ceded it back to Turkey. The Byzantines called Erzurum Theodosiopolis and used it as a frontier fortress. In the World War the Russians captured it again in a spectacular military engagement.

The iron and copperware of Erzurum are well known in the Near East, and carpets, shawls, boots and saddles are manufactured in considerable quantities. Barley, wheat, millet and vegetables are grown on the nearby plain. Pop. 1927, 78,134.

ESAU, in Biblical account, the son of Isaac and Rebecca and Jacob's elder twin brother. He later acquired the name of Edom (red) and is thus apparently the progenitor of the Edomites. The stories of how Esau sold his birthright to Jacob for a meal of pottage and how Jacob gained the blessing intended for Esau, the first-born, serve to indicate the traditional enmity between the Edomites and the Israelites and an attempt to account for the favored position of the Israelites.

ESCANABA, a city of northwestern Michigan, the county seat of Delta Co., situated on Little Bay de Noquette, an inlet of Green Bay, which is tributary to Lake Michigan, about 60 mi. south of Marquette. Airplanes, bus lines and three railroads afford transportation. The city is a shipping point for much of the Lake Superior iron ore. Leading manufacturers include furnaces, cinder products, lumber, hard-maple flooring, paper, veneers and chemicals. The factory output 1929 was worth \$4,670,905. In 1929 the retail business reached a total of \$8,671,604. The city is in the center of an agricultural district yielding potatoes, corn, hay, alfalfa and oats. Escanaba is located on a bluff overlooking the water. Its climate, the picturesque countryside and the excellent boating and trout-fishing make the city a popular summer resort. Escanaba was settled about

1863, taking its name from an Indian word meaning Flat Rock. It was incorporated in 1866. Pop. 1920, 13,103; 1930, 14,524.

ESCARPMENT, a bold-faced cliff, or steep slope, forming a continuous sharp ridge. Such abrupt declivities often occur along the edge of a plateau capped with strong, resistant rock. The striking Niagara Escarpment, near Lake Ontario, represents the outcropping of Niagara limestone topping a long rampart which drops 300 ft. from the Lake Erie plateau. Niagara Falls originally dropped over this escarpment at Lewiston, N.Y. The famous Helderberg Mountain near Albany, is an escarpment of the dissected Allegheny Plateau. In arid regions, where rain-weathering is slow, canyon-cutting results in well-developed escarpments sometimes 2,000 ft. high. The upthrust of rock along one side of a break or **FAULT** often produces a vertical cliff. Many picturesque elevations in the Adirondacks are weathered fault scarps.

ESCHATOLOGY, from a Greek word, *eschata*, meaning the last things, the term for that part of a religious faith or theology which treats of the final condition of the human race and of the world. Within its doctrine of eschatology come whatever pronouncements or predictions a religious system offers of the final destiny of the race. With the possible exception of Confucianism, all religions have an eschatology. The eschatology of the Bible and Christianity rests on the idea that history is a moral process moving slowly toward goals of good or evil, which are made the actual fruit of experience. Many of the eschatological ideas of Christianity were derived from the Jews, who in turn were influenced by the eschatological ideas of the Zoroastrians and the early Egyptians and Babylonians. In the study of Biblical eschatology it is usual to distinguish between the doctrines, treating the Old Testament and the apocalyptic books of its Apocrypha separately from the eschatological ideas of Jesus as set forth in the Gospels, and the distinctly different ideas of the Pauline Epistles. In Biblical eschatology, the student deals with such topics as Immortality, Heaven, Hell, the Intermediate State or Purgatory, the Second Coming of Christ, the Millennium, the Judgment Day and related subjects.

ESCH-CUMMINS ACT, 1920, providing that the railroads of the United States, operated by the national government as a war emergency measure, be returned to private ownership. This relinquishment was to occur on Mar. 1, 1920; until Sept. 1 the railroad companies were to be guaranteed earnings equivalent to those received under governmental control, and the Interstate Commerce Commission was to determine what rates would enable the roads to earn a net income equal to 5½ per cent of their value until 1922 and subsequently a "fair return." A revolving fund of \$300,000,000 was created to facilitate financing during the transition period. The **INTERSTATE COMMERCE COMMISSION** was to work out a scheme of consolidation to eliminate duplication of service and

equipment. A Railway Labor Board was created to deal with wages, working conditions, and similar matters of controversy; this was, however, but a superficial endeavor to settle the labor problem, and the provision was repealed in 1926. The provision for guaranteed earnings proved most expensive to the Government, over \$600,000,000 from the Treasury being paid out during the first six months of private operation.

ESCORIAL, THE, the gigantic mausoleum, monastery and royal residence of the kings of Spain, lying in the foothills of the Guadarramas some 31½ mi. northwest of Madrid. It was erected in the 16th century by Philip II in fulfillment of a promise made his father, Charles V, to provide a tomb for him. Juan Bautista of Toledo began construction in 1563. The building, said to be some ¾ mi. around, is constructed of gray granite in the form of a square. Its corridors run for over 100 mi., there are 14 courts, 86 stairways, and some 2,700 windows; the church has upwards of 50 altars. Behind the high altar is the pantheon erected at Philip's order as a burial vault for his father and himself and all the succeeding kings of Spain. Adjoining it are the sarcophagi of the infantas and the queens of Spain. Philip's library and his private apartments adjoining the Hall of Battles are of especial interest.

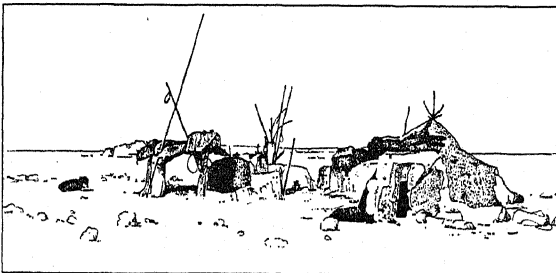
ESCUDO, the monetary unit of Portugal, known as the *milreis* previous to the revolution and formerly nominally equivalent to \$1.08; also, a Portuguese gold or silver coin of this value. Since Portugal does not have a full **GOLD STANDARD**, the value of the escudo has fluctuated widely. By a decree effective July 1, 1931 the value of the escudo was set at 4.42 cents.

ESENIN, SERGIUS (1895-1925), Russian poet, was born Oct. 4, 1895 in the village of Constantinovo, Ryazan, of peasant parentage. Because of the proletarian nature of his themes and style, he was known as the "hooligan poet" and was idolized in the cafés of Moscow. He was twice married, the first time, in 1922, to ISADORA DUNCAN. With unassailable beauty of style, his poetry is a combination of the coarseness and melancholy typical of Russian folk-song. His lyrics and elegies have the gift of melody, permeated with heart-breaking lament for passing beauty. Esenin committed suicide at Leningrad, Dec. 28, 1925.

ESKER, a narrow, sinuous ridge of stratified gravel and sand, marking the ancient channel of a glacial stream. Such ridges persist in numbers in Finland, Scandinavia, and Ireland. They also form a conspicuous feature of New England topography, especially in Maine. Usually they rise ten to fifty or more feet above the surrounding level, and are less than a mile long. Individual esker ridges, however, have been traced for miles, stretching in the general direction of the ice-flow. They are supposed to have been built by sediment-laden streams, tunneling under the stagnant ice-cap. With the retreat of the supporting ice, the debris slumped into its present embankment form.

ESKILSTUNA, a city of Sweden, situated 65 mi. southwest of Stockholm. It occupies first place in Sweden as the industrial center of iron and steel work. There are important engineering plants and an industrial metal school. The manufactures include hardware, firearms and cutlery. The city is supposed to derive its name from an English missionary named Eskil, who died here in the 13th century. Pop. 1931, 32,674.

ESKIMO, a group of American aboriginies, comprising with the ALEUT the Eskimoan linguistic stock. The Eskimo occupy scattered islands and coast regions in a territory extending from Greenland to the east coast of Siberia. They have been divided into the following ethnological groups by Dr. Franz Boas: the Greenland Eskimo, the Eskimo of southern Baffin Land and the northwest shore of Hudson Bay, the Sagdlirmuit of Southampton Island, the Eskimo of Boothia Felix, King William Land, and the neighboring mainland, the Eskimo of Victoria Island and Coronation Gulf, the Eskimo between Cape Bathurst and Herschel Island, including the mouth of the Mackenzie River, the Alaskan Eskimo, and the Yuit of Siberia. A striking similarity of language and customs exists throughout the great extent of Eskimo domain. Culture traits which are almost universal and differentiate the Eskimo from the rest of the continent include camping on sea ice and living on seal in the winter and upon land and land animals in the summer; also the kayak, the "woman's boat," harpoon, woman's knife, bow-drill, snow goggles and dog sledges. A skin tent is the general summer



COURTESY AMER. MUS. OF NATL. HISTORY

AN ESKIMO HOUSE AND CACHE ON PRINCE ALBERT SOUND

dwelling and in addition to the snow-house, which prevails east of Point Barrow, the usual winter dwelling is a framework of wood or whale ribs laid over a shallow excavation and covered with turf and earth. Clothing is made from animal furs and bird skins.

Physically the Eskimo constitute a distinct type. On an average they are of medium stature, are corpulent and have uncommon strength and endurance. Their skin is a light brownish yellow; their faces are broad and round and their eyes have a distinct Mongoloid character. They have happy dispositions and have a reputation for truthfulness and honesty. The men do the hunting and fishing, the women practically all the rest of the work, including pitching of tents, repairing of kayaks and boat covers, drying of fish and meat and the making and mending of

clothing. Social and governmental organization is practically lacking. The village is the largest unit and one man, usually the one who is able to support the greatest number of dependents, acts as a kind of advisory head but has no authority to enforce his opinions.

The purest Eskimo culture is found in the region between Banks Island and North Greenland, justifying the conclusion that, whereas the Eskimo may originally have come from Asia, the present cultural development originated in this eastern region and has spread westward.

ESKI-SHEHIR, a city of Turkey in Asia Minor, capital of the vilayet of the same name, situated on the Pursak or Tembris River, a tributary of the Sakaria. The branch line from Konia joins here the Constantinople-Angora trunk line. A mile away are the ruins of ancient Dorylaeum, which figured in the wars of Lysimachus and Antigonous. The Byzantine Emperors lived at Dorylaeum and used it for military headquarters. The Crusaders defeated the Turks here in 1097. The meerscham mines, mineral springs and climate of Eski-Shehir are famous. Pop. 1927, 81,759.

ESMARCH, JOHANNES FRIEDRICH AUGUST VON (1823-1908), German surgeon, was born at Tönning, Schleswig-Holstein, Jan. 9, 1823, and died at Kiel on Feb. 23, 1908. He studied at Kiel and Göttingen. In 1846 he became von Langenbeck's assistant at the Kiel surgical hospital and 1857 head of the general hospital and professor at Kiel University. He was a great military surgeon, having served in the field hospitals during the Schleswig-Holstein wars of 1848 and 1864, and in the Franco-Prussian War of 1870 was appointed surgeon-general to the army and subsequently consulting surgeon at the great military hospital near Berlin. He was a noted authority on hospital management and military surgery, did much to improve bandaging technique and invented an apparatus, known as the Esmarch bandage, which is of advantage in that it expels blood from the portion that is to be operated on. M.F.

ESMERALDA, the heroine of Victor Hugo's *NOTRE DAME DE PARIS*. She is a dancing gypsy girl whose beauty, arousing the passions of the villainous Dom Frollo, at last causes her to be executed as a witch.

ESOPHAGUS, a muscular tube in the alimentary canal, connecting the mouth and pharynx with the stomach. It is about 10 inches long and from $\frac{1}{2}$ to 1 inch in diameter. It courses through the neck and thorax behind the trachea or wind-pipe and the heart and between the lungs, perforating the diaphragm to join the cardiac end of the stomach. It is lined with stratified squamous EPITHELIUM and is covered with an outer longitudinal and an inner circular layer of smooth muscle in its lower two-thirds, and of similar coats of striated muscle in its upper third.

Tumors of the esophagus, especially cancer, may cause stricture, thus rendering swallowing difficult or impossible.

ESOTERIC, that which is confined to a few, the opposite of exoteric. An esoteric school is an exclusive one. Teachings given only to an inner circle are esoteric. Private beliefs may differ from those given out for popular consumption. The former are esoteric, the latter exoteric.

ESPARTO GRASS (*Stipa tenacissima*), a species of spear-grass strongly resembling the feather-grass cultivated in gardens. Esparto is native to southern Spain and northern Africa, where it is also called halfa or alfa. It grows in large clumps attaining a height of 4 feet. The leaves, sometimes 3 ft. long, contain a fiber of great tenacity and flexibility, extensively used in the manufacture of paper.

ESPERANTO, an international language invented in 1887 by L. L. Zamenhof, a Polish oculist. It is based on 16 grammatical rules which admit of no exceptions and which include a single case-ending, with distinctive terminations for each part of speech, the plural, and the tenses of the verb, the latter having no inflections for person or number. Words are formed by affixes, which are mostly international with a single and invariable meaning, and by the juxtaposition of roots. Some 80% of the vocabulary is derived from modernized Latin roots as now found in western European languages; the remainder is based chiefly on German roots. Its literature includes both translations and original compositions, besides many periodicals, including one in BRAILLE. Of recent years it has been used in a number of international conferences not directly interested in the international language movement, while, following the advice of the *Union Internationale de Radiophonie* in 1927, many stations now broadcast in Esperanto. In 1907 Marquis de Beaufront, a former Esperantist, changed certain elements in the language, naming this modified form Ido (Esperanto "offspring"). Two periodicals are published in Ido, but otherwise it manifests little activity. H. S. E.

BIBLIOGRAPHY.—L. L. Zamenhof, *Ekzercaro*, 1894, and *Universala Vortaro*, 1894; *Fundamento de Esperanto*, 1905.

ESPIONAGE, the act of obtaining and transmitting, by underhand means, information which is likely to prove harmful to a state or government. Espionage proper is essentially military and usually falls into two successive phases; obtaining information by bribery or other means, and secretly conveying it, by messenger, cipher or code. In as much as the act may threaten the very existence of a state, penalties are severe even in peace time. In time of war, death is the usual penalty.

ESSAY, a short prose composition dealing in a markedly personal manner with some subject of interest to the writer. The inventor of this popular literary form was the Frenchman MICHEL DE MONTAIGNE, who began writing his famous informal notes in 1571, forming a collection which has never been surpassed for easy grace, charm and intense interest. He remains to this day one of the supreme essayists. FRANCIS BACON is dry and flinty in comparison, although his subject matter is seldom dull. The 18th

century produced the great names of Steele and Addison, Goldsmith, Johnson, and the 19th those of Hazlitt, Hunt, DeQuincey, Macaulay, Charles Lamb, Arnold, Pater and Stevenson. In America Washington Irving, Thoreau, Poe, Emerson, Lowell, Howells, Woodberry and Paul Elmer More have all added distinction to the essay. See also separate articles on the above authors; FRENCH LITERATURE; ENGLISH LITERATURE.

BIBLIOGRAPHY.—J. B. Priestley, *Essayists Past and Present*, 1925.

ESSELENIAN, the name of a California Indian tribe and linguistic stock which is considered by some students to be one of the components of the HOKAN stock. Never a large group, with territory centering in the drainage of the Carmel River, they were as early as 1770 under mission influence and were consequently exterminated, like most of the so-called Mission tribes. No information, except for some data on the language, is extant as to their general culture.

ESSEN, a city of the Prussian Rhine province, about 21 mi. northeast of Düsseldorf. It is an important industrial city in western Germany and is the center of the great coal and manufacturing region of the Ruhr. Since its merging with the outlying territories of the district in August, 1929, it has more than quadrupled its population. The old part of the town contains the few ancient buildings, including the minster, founded 852, and several times rebuilt. Towards the west the large Krupp plants extend, occupying an entire district of the city. The other outlying districts contain the other great plants and colonies for workmen. The mining industry embraces 132 mines and the new greater city is the seat of numerous allied industries. Pop. 1925, 470,524.

ESSENES, a Jewish ascetic and communal sect or order which began to flourish in Palestine about 150 B.C., and which disappeared soon after the destruction of the Second Temple in 70 A.D. The name Essenes has variously been explained as meaning healers, pious, bathers or hidden ones; however, its actual etymology will probably never be known.

The Essenes were a branch of the PHARISEES who strove to attain to the highest degree of holiness through observing the most rigid rules of Levitical purity. They dwelt in communal houses situated outside of the limits of the towns of Palestine. They stringently practiced community of property, and lived exclusively through the work of their own hands. Much of their time they gave over to study, devotion and the practice of benevolence. They took great care to keep themselves physically and morally clean; practiced abstemiousness, a strict moral and ethical code, avoiding too much sensual pleasure, including connubial intercourse, and lived in utter seclusion from the surrounding world. They regarded their life as a preparation for the kingdom of heaven, which was soon to be brought about.

Like the later convents and monasteries of the Christian Church, the Essenes subjected all candidates

for admission to the sect to a three-year period of rigid probation. A one-year period of probation was required before they were even admitted to the prescribed ablutions performed by all members of the order. The Essenes bathed in running water every morning, for which reason they were called Morning Bathers (cf. Hemerobaptists). The chief occupation of the Essenes was agriculture. All forms of commercial enterprise, wealth, and the making or employment of weapons of war were rigidly prohibited. They took all meals at the common table in absolute silence. The Essenes rejected the Temple sacrifices, and refused to carry them out. However, they were extremely scrupulous in their observance of the Sabbath. In general they were opposed to marriage. They regarded Moses as the greatest character in the Bible, almost as divine. They firmly believed that through Scriptural study and through the observance of the laws of ritual purity they would be enabled to predict the future and to become worthy of the Holy Spirit, or *Ruah HaKodesh*, the manifestation of the presence and power of God.

Of the various doctrines of the Essenes, and of their many strange practices, that of celibacy is undoubtedly of non-Jewish origin; others are believed to go back to Persian, Buddhist, or even to Pythagorean influences. The teachings of the Essenes undoubtedly had great influence over nascent Christianity, but were entirely without influence on Judaism. Indeed, so remote were they from the basic principles and practices of true Judaism, and so remote from life, with which Judaism had always concerned itself, that the Essenes made very few converts from Jewish ranks, and disappeared from human history after two scant centuries, without leaving a single trace or vestige in Judaism of their doctrines, beliefs and practices. A. SH.

BIBLIOGRAPHY.—Eduard Meyer, *Ursprung und Anfänge des Christentums*, 1921, vol. 2; Graetz, *History of the Jews*, 1926; Bousset, *Religion des Judentums*, 2nd ed., p. 524 et seq.

ESSENTIAL OILS, also called volatile oils, odoriferous substances usually oils, but sometimes solids, derived almost exclusively from vegetable sources. The flavor and odor of spices, barks, berries, herbs, fruits, seeds and flowers are due to the essential oils contained within their cell structure. The oils are obtained by extraction with solvents, enfleurage or by steam distillation. All parts of the world contribute some essential oils although each species of oil bearing plant requires its own special climate. The roses of Bulgaria give the best oil of rose, while the flowers of the Grasse region of France are most prolific both in abundance and bloom and essential oil content. The United States produces orange, lemon, sassafras, wormwood, birch, wintergreen and peppermint oils as well as TURPENTINE and pine oil. The knowledge of essential oils was greatly increased with the development of organic chemistry in quite recent times. This science helped to determine the constituents of the oils and to develop processes for extracting and in many cases synthetically preparing them. While the

ancients knew the sources of the oils, man's knowledge of their actual chemical nature has been very recent. Essential oils themselves are mixtures of complex organic chemical bodies. The oils or their constituents are used chiefly in pharmaceuticals, perfumes and flavors. Natural supply cannot equal the demand for these products. If it were not for synthetic methods of manufacture, their cost would be much greater.

E. H. B.

ESSEX, ROBERT DEVEREUX, Second Earl of (1567-1601), was born at Netherwood, Herefordshire Nov. 19, 1567. After obtaining his degree at the University of Cambridge in 1581, and winning military glory at the battle of Zutphen in Holland in 1585, he entered the court of Queen ELIZABETH who was immediately impressed by his good looks and courtly bearing. The death of the Earl of Leicester, step-father of Essex, left the position of royal favorite open and the fickle queen soon established the youthful Essex as his successor. By his marriage to the widow of Sir Philip Sidney in 1590, Essex incurred the serious displeasure of the Queen. He managed, however, to assuage her wrath and gained fame in the naval attack on Cadiz in 1596. His failure as governor-general of Ireland in 1598 led to a complete break with the queen and he was brought up for trial on charges of treason in 1601. His former friend, Francis Bacon, was the prosecutor who now turned against him in a merciless indictment. He was condemned to death and executed Feb. 25, 1601.

BIBLIOGRAPHY.—L. Strachey, *Elizabeth and Essex*, 1928.

ESSEX, a kingdom of Anglo-Saxon Britain comprising the land of the East Saxons. In Anglo-Saxon times the territory comprised what is now Hertfordshire and Middlesex as well as of Essex. Little is known that is authentic of the 7th and 8th century kings of Essex, but in 825 Essex became tributary to Egbert, King of Wessex. Essex fell under the power of the Danes in 870, and thereafter figures in history as an earldom rather than a kingdom.

ESSEX and ALERT, two warships which engaged in a combat Aug. 13, 1812, resulting in an American naval victory in the WAR OF 1812. Disguised as a merchantman, the *Essex*, an American frigate, with 46 guns and 325 men under command of Capt. Porter, sailing northward from Sandy Hook, by pretended flight enticed the English vessel *Alert*, with 26 guns and 130 men under command of Capt. Langhorne, within close range. A sudden damaging fire against the port quarters of the *Alert* demoralized the British crew. Barely eight minutes after the first shot the *Alert* was in a sinking condition, and struck colors. It was the first British national vessel captured in the war. Three of its crew were wounded; the *Essex* suffered no injury.

ESSEX JUNTO, a name in Massachusetts history applied by JOHN HANCOCK to conservative political leaders who supported James Bowdoin, nominee for governor in 1785. The majority of these leaders

were residents of Essex County, in northeastern Massachusetts, a region dominated by commercial and fishing interests, and consequently favoring a strong national government. The "Junto" headed the Federalist party in the State, and adhered to ALEXANDER HAMILTON when the national leadership of the party was disputed between Hamilton and John Adams. The group lost its political influence when the HARTFORD CONVENTION brought the ultra-Federalist leaders into disrepute. George Cabot, members of the Lowell family, Theophilus Parsons, Stephen Higginson, Timothy Pickering, Benjamin Goodhue, and Fisher Ames were the chief members of the "Junto."

ESSLINGEN, city in Württemberg on the Neckar, about 26 mi. east of Stuttgart. It has noteworthy buildings, an old castle, a 15th century rathaus, a new rathaus of the 18th century, and a Romanesque-Gothic Dionysius Church of the 13th century. Esslingen is one of the most important manufacturing cities in Württemberg, with railroad and machine shops, locomotive plants, metal goods and glove factories, weaving and spinning mills, vegetable and fruit growing and wine making. It was built near a chapel erected in 784, was a free imperial city after 1209 and fell to Württemberg in 1802. Pop. 1925, 40,586.

ESTAING, JEAN-BAPTISTE CHARLES HECTOR, COMTE D' (1729-94), French admiral, was born at Ravel, Puy-de-Dôme, Nov. 28, 1729. He served in India under Count Lally-Tollendal and commanded (in 1778-80) the fleet sent to help the Colonial forces against the British in America. Estaing's fleet was successful, particularly in the West Indies, where, on July 6, 1779, he besieged Admiral Byron at Grenada. His sympathies were with the French Revolution, and though he was in command of the National Guard in 1789 and in 1792 was chosen admiral by the National Assembly, still he was, in 1794, brought to trial as a noble and died on the guillotine, Apr. 28, 1794.

ESTATE, an interest in lands. Estates may be of inheritance or not of inheritance. Estates of inheritance are those which pass to the heir, namely, estates in fee simple, and estates tail. Estates not of inheritance include life estates, estates for the life of another, and estates for years. Estates in fee simple and fee tail and life estates are called freehold estates. They are real property.

ESTATE DUTIES, *see* INHERITANCE TAX.

ESTATES GENERAL, THE, was the French Parliamentary Assembly. The Estates General consisted of representatives of the three orders, clergy, nobility and Third Estate. It came into existence about 1300 when as, at later times, it was called by the King to get its support and agreement to taxes. At one time it had a fair chance to develop into a real Parliament after the English fashion and become, not only a check on the power of the King, but a body with initiative and power in the Government. After the meetings of the Estates General in 1617, however, Richelieu managed affairs so successfully that the need

for the calling of the Estates did not again occur till 1789.

In that year the last Estates General met in Versailles on May 5, amid much pomp and splendor, the King, Louis XVI, presiding. It was composed of 308 deputies chosen by the clergy, 285 by the nobility and 621 elected by the Commoners. Unfortunately no one had thought out a constructive program for reform which the nation manifestly expected. Instead the Comptroller of Finance Neckar spent hours telling the deputies of the financial needs of the King, and the need of new taxes. After that the Estates adjourned till the following day, when a controversy developed which lasted for eight weeks over the question whether the three orders should meet separately or as a single body. The clergy and nobility insisted on meeting separately and vote by order, while the Third Estate demanded that they meet together and vote as individuals, or by head. On June 17 the Third Estate, impatient at the refusal of the other two orders to join them, declared, that since they represented 96 per cent of the nation, they alone could make a Constitution, and proclaimed themselves "the National Assembly of the French Nation." The King sided with the privileged orders, and on June 20 had the place of meeting of the Third closed. Surprised and indignant, the deputies assembled on an adjoining tennis court and swore not to separate till they had given a Constitution to the realm.

Again the King tried coercion, this time in a Royal Session, ordering the Estates to sit separately. The deputies, led by Mirabeau, flatly refused to obey. When the King was told, he meekly acquiesced, and ordered all the deputies to meet together. From this time on this remarkable assembly, which continued till Sept. 30, 1791 was known as the National or Constituent Assembly.

ESTERHAZY VON GALANTHA, NIKLOS JOZSEPH (Nicholas Joseph) (1714-90), soldier and patron of art, was born Dec. 18, 1714. He was the descendant of an ancient, noble Magyar family of immense wealth. Able ambassador at various courts, he also distinguished himself in the SEVEN YEARS' WAR and became field-marshal. Esterhazy was a patron of art and science, and maintained at Eisenstadt his famous orchestra, of which JOSEF HAYDN was for thirty years conductor and for which he composed innumerable symphonies, sonatas and other musical masterpieces. Esterhazy died, Sept. 28, 1790.

ESTERIFICATION, a term in organic chemistry denoting the combination of an alcohol with an acid, with elimination of water. The process of esterification resembles that of neutralization, and esters were, for that reason, incorrectly termed ethereal salts. *See also* ESTERS.

ESTERS, organic compounds formed by the union of acids and alcohols. The esters of organic acids are neutral, generally colorless, volatile liquids with a pleasant odor. They are often used as artificial fruit essences. Mineral acid esters are sometimes neutral and sometimes acidic, forming salts with bases.

Among the esters used in medicine are methyl salicylate (oil of wintergreen), ethyl acetate, etc. *See also* ESTERIFICATION.

ESTES PARK, a village in Larimer Co., Col., at the entrance to ROCKY MOUNTAIN NATIONAL PARK, lying at an elevation of 7,500 ft. above sea-level and surrounded by high peaks. It was named for Joel Estes, the first permanent settler in the region, who founded the village in 1858. It was incorporated in 1917. The Park was long the property of the Earl of Dunraven. A popular stopping place for tourists, Estes Park is 75 mi. northwest of Denver and 23 mi. northwest of the nearest railway station at Lyons; it is served by an airport. Pop. 1930, 417.

ESTHER, BOOK OF, in the Old Testament, is named after the heroine of its story, a Jewess who became the Queen of a Persian king named Ahasuerus, and who in this position protected her race from a plot designed for their destruction. In memory of this deliverance, it is said, the Feast of Purim was instituted. While accepted as true by the large majority of Bible readers, many scholars hold the story to be unhistorical, as a Persian Ahasuerus with a Jewish Queen issuing edicts for the slaughter of his own race to revenge her cannot be confirmed, and the origin of the Feast of Purim is obscure. It was probably written to support that feast and dates from about the 2nd century B.C.

ESTHERVILLE, a city in northwestern Iowa, the county seat of Emmet Co. It is situated on the Des Moines River, 70 mi. northwest of Fort Dodge and served by two railroads and by bus lines. It is a trade center in a grain and stock-raising region. Nearby is Fort Defiance which protected the early settlers from the Indians. This was made a state park in 1931. Estherville was incorporated in 1862. The electric, gas and water plants are municipally owned. Pop. 1920, 4,699; 1930, 4,940.

ESTHONIA. *See* ESTONIA.

ESTONIA, a small republic of northern Europe, established after the World War in 1918. It is bounded on the north by the Gulf of Finland, on the west by the Baltic and the Gulf of Riga, on the south by Latvia and on the east by Russia. Area 18,353 sq. mi. Besides the mainland, included in the territory of Estonia are a number of islands the largest of which are Saaremaa, Hiiumaa, Vormsi and Muhumaa. The country is divided into 11 districts: Saaremaa, Harju, Viru, Jarva, Laane, Tartu, Võru, Viljandi, Pärnu, Petseri and Valga. TALLINN is the capital. Other important cities are the university town of TARTU, the port of PÄRNU, and the manufacturing town of NARVA. Geographically the country consists of a lowland plain, the highest point of which is 450 ft. above sea level. About 20% of its surface is covered with forests and the land is dotted with lakes. Approximately 70% of the population is engaged in agriculture and dairying. In 1929 Estonia produced 145,703 metric tons of rye, 34,300 tons of wheat, 123,811 tons of barley, 753,032 tons of potatoes and 149,172 tons of oats. In 1928

the industries of the country employed 36,637 persons. Chief among these are the textile, paper, cement, oil, match and leather industries. The total imports for 1930 amounted to 98,369,500 *kroons* while the total exports for the same year came to 96,433,800 *kroons*. The principal imports are grain, cotton, fish, textiles, metals and machinery, while the main exports are dairy products, timber, textile products and paper.

The constitution was adopted in 1920. It provides for a state assembly of 100 members, elected by universal suffrage on the basis of proportional representation, and with a term of office of three years. The chief executive is the state head of the government, the latter being chosen by the assembly. Rights of the initiative and the referendum lie with the people. The state court of justice is also elected by the state assembly. Although there is no state religion, the great majority of the population belongs to the Lutheran faith, about five-sixths being members of this denomination. The rest are mostly Greek Catholics. Of the 1,300 elementary schools in 1928-29, 1,268 were public, leaving but 32 private institutions of this rank. Among the schools of higher learning are five teachers' seminaries, three navigation schools, commercial, agricultural, industrial, and art schools, Tartu University and the Tallinn Technical Institute.

In 1929 Estonia had 770 mi. of railroad. The revenue for 1930, in thousands of *kroons*, was 95,924; the expenditures were 95,729. The *kroon* is the monetary unit of the country. The Bank of Estonia was established in 1919 with a capitalization of 10,000,000 *kroon*, which in 1921 was raised to 250,000,000. Approximately 87% of the inhabitants are Estonians, 16% Russians, and 1% Germans. Est. pop. 1931, 1,117,000.

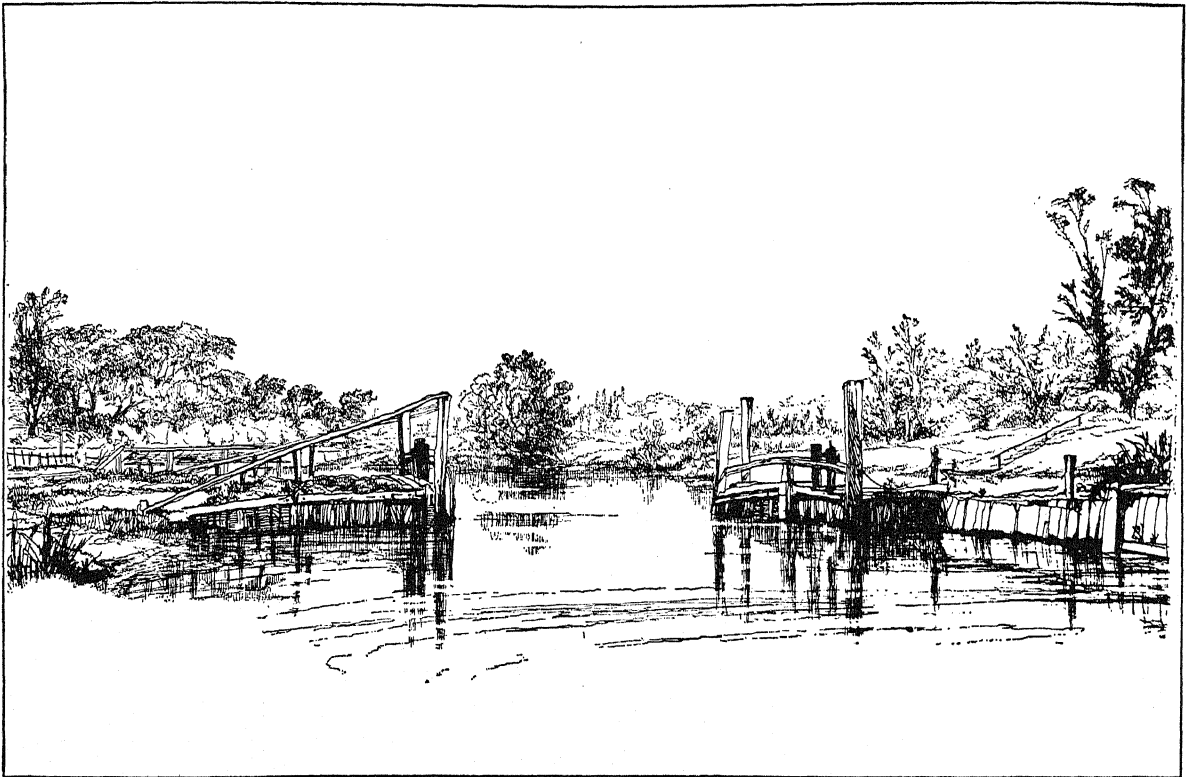
History. The Estonians, a people closely related to the Finns, had lived along the southern coast of the Gulf of Finland having little or no contact with western European civilization until missionary efforts were begun there in 1202 by the Knights of the Sword, one of the orders of German knights, later to be absorbed by the Order of Teutonic Knights. Gradually the country came under the control of the Order, the members setting themselves up as a German aristocracy above the Estonian peasants. The city of Reval, however, was founded by Valdemar II of Denmark in 1219 and remained an eastern trading post of the Danes until it was sold to the Teutonic Order by Valdemar IV in 1346.

With the decay of the German power in the Baltic and the growth of Sweden, Swedish influence grew in Estonia until in 1561 Sweden annexed the entire region. But under Sweden little change occurred, save for the introduction of Protestantism. The Germanic aristocracy still maintained its secure position. At the close of the Northern War in 1721 Sweden was forced to cede Estonia to Russia, but it was not until late in the 19th century that the Russian government began any serious effort to stamp out Estonian customs and the Estonian and German languages.

The overthrow of the Tsar in the spring of 1917 was welcome in Estonia and a local Diet was organized, but the Bolshevik revolution in Nov. decided Estonia to cut loose from Russia and on Nov. 24 the Diet declared Estonia independent. By the spring of 1918 the local Germanic nobility which controlled the Diet had secured a firm hold upon the country and began arrangements for union with Germany, but the collapse of Germany in the fall left the Diet with almost no army, and Red troops immediately began invading the country. These, however, were checked by British warships and by troops from Finland, and after the spring of 1919 the country was again peace-

and has undertaken to engage, so far as possible, in a common foreign policy with them. The attempt in 1925 to secure increased compensation for the dispossessed landlords failed, and the Republic has consistently maintained a balanced budget and a sound fiscal policy, preferring high taxes to a swollen public debt.

ESTONIAN, a FINNO-UGRIC language closely related to FINNISH and spoken by about 1,500,000 people. Both in consonantism and in vocalism it has undergone more changes than Finnish, and much leveling has taken place in declensions and conjugations, although on the other hand it has preserved



COURTESY METROPOLITAN MUSEUM OF ART

"EGHAM LOCK"

An etching by Sir Francis Seymour Haden (1818-1910)

ful. In Oct. the large rural estates were broken up among the formerly landless peasants and in June 1920 a constitution was adopted providing for proportional representation, and the popular initiative and referendum. Russia was the first nation to recognize Estonia, Feb. 1920, and since then the two countries have maintained harmonious political and close economic relations, each being necessary to the other, except for a brief and unsuccessful Red *putsch* at Reval, Dec. 1, 1924 which led to the banning of the Communist Party in Estonia.

Estonian independence was recognized by the former Allies in Jan. 1921, and by the United States in July 1922. In Nov. 1923 a customs union was effected with Latvia, and in 1925 Estonia joined with her three Baltic neighbors in a local Arbitration Court

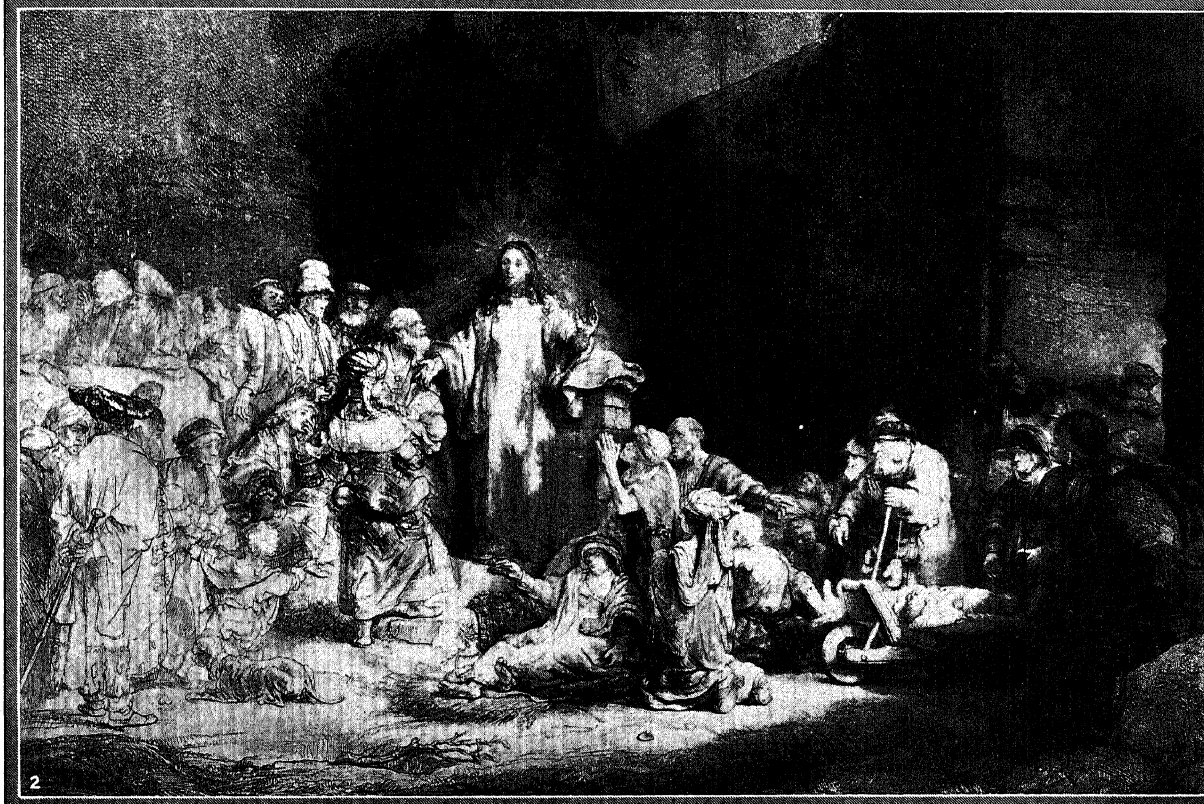
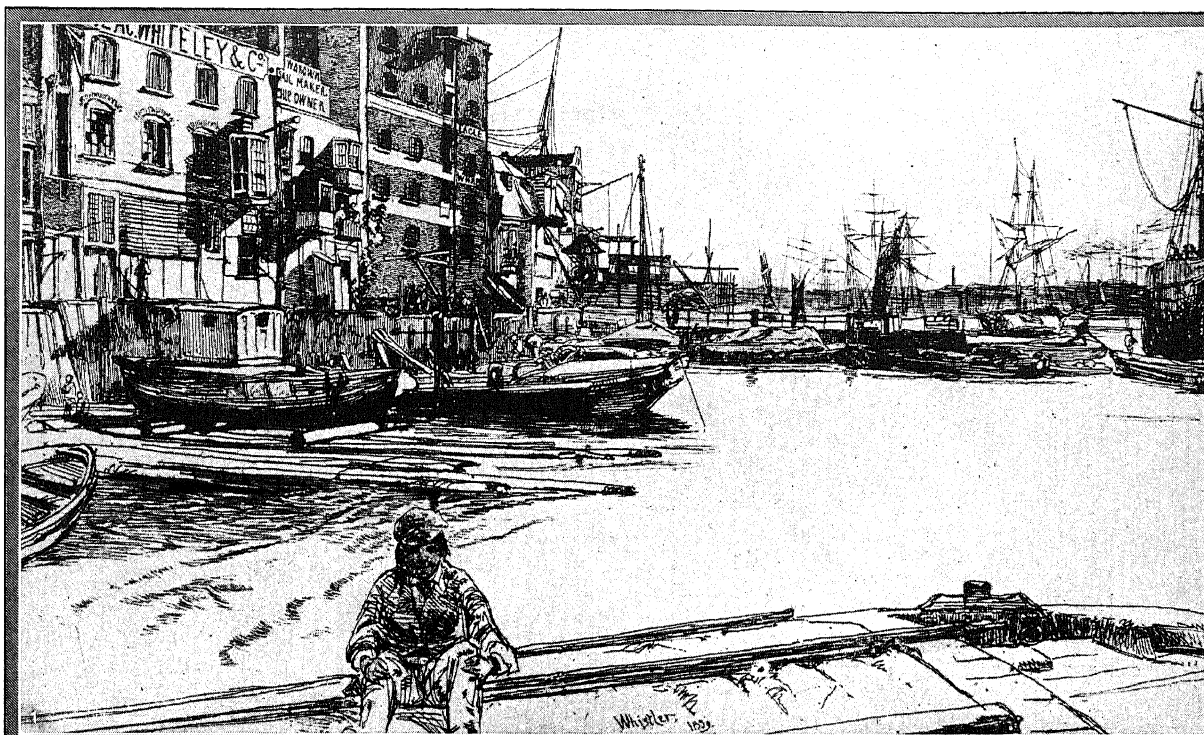
archaic features lost in Finnish. Estonian is divided into the two main dialects of Reval and Dorpat, the modern literary language being based on the former, with much Finnish influence. The first literary documents are from the early 17th century, and the Estonian folk-epic *Kalevipoeg* appeared in 1857. Low German influence is noticeable both in vocabulary and in syntax, and Estonian has created a future and a passive, with the verb *sab*, used like the German *werden*.

B. J. O.

BIBLIOGRAPHY.—F. J. Wiedemann, *Grammatik der estnischen Sprache*, 1875; M. Neumann, *Praktisches Lehrbuch der estnischen Sprache*, 1926.

ESTOPPEL, the preventing a person from asserting or denying an alleged fact which has been established as record or judgment, by deed, or by

ETCHING

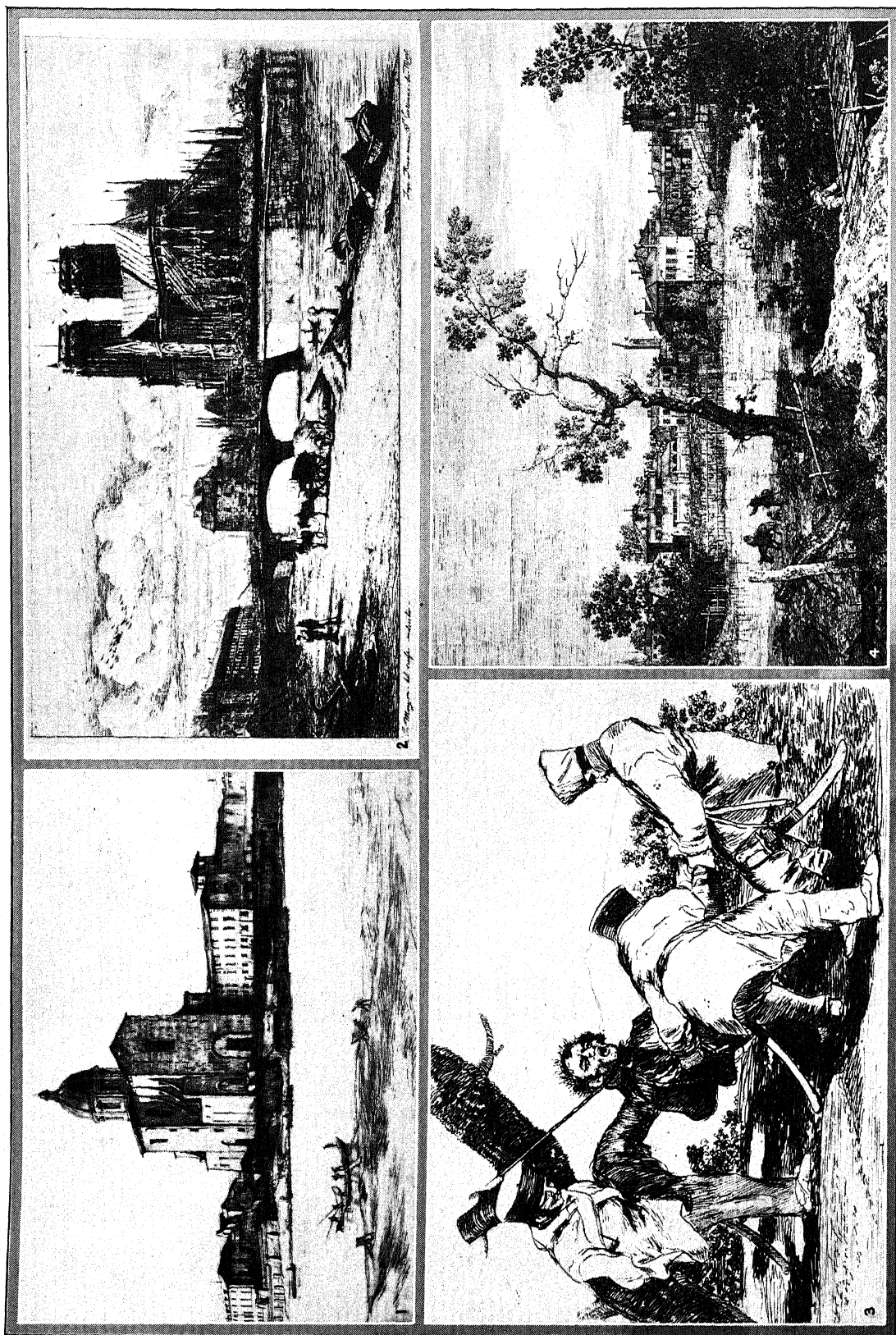


COURTESY METROPOLITAN MUSEUM OF ART

CELEBRATED ETCHINGS

1. "Eagle Wharf," by James Abbott McNeill Whistler (1834-1903).
2. "Christ with the Sick Around Him, Receiving Little Children," by Rembrandt van Ryn (1606-69).

ETCHING



COURTESY METROPOLITAN MUSEUM OF ART

OUTSTANDING EXAMPLES OF ETCHING IN EUROPE

1. "San Fediano in Celeste," by Muirhead Bone (1876-). English.
2. "Notre Dame de Paris," by Charles Méryon (1821-68). French.
3. "¿Por qué?" from the series, "Disasters of the War," by Francisco Goya y Lucientes (1746-1828). Spanish.
4. "Untitled etching by Antonio Canaletto (1697-1768). Venetian.

conduct of the person estopped. For example, if a vendor has made certain statements by which he induced the vendee to purchase, he may be estopped from showing the contrary. The person who invokes the estoppel must act in good faith.

ESTOURNELLES DE CONSTANT, PAUL HENRI BENJAMIN, BARON D' (1852-1924), French writer and diplomat, was born at La Fleche, Nov. 22, 1852. Educated in Paris, he entered the diplomatic service, holding posts in Montenegro, Tunis, Netherlands and England, being in the embassy at London from 1892 to 1894. In 1895 he was elected to the Chamber of Deputies, served continuously until 1904 when he was made Senator. He was distinguished for his work in the cause of international peace, and with the Belgian, Auguste Beernaert, received the Nobel prize for peace in 1909. A monument to him, as worker for peace, was unveiled in Le Mans in July, 1930. He died at Bordeaux, May 15, 1924.

ESTRADA CABRERA, MANUEL (1857-1924), President of the Republic of Guatemala. Under the Presidency of General Reina Barros he was minister of government and of justice. Upon Reina's assassination, Feb. 8, 1898, he became president of the Republic for an indefinite length of time. He was named president by the assembly, for the period 1899-1905 and reelected in 1905 to serve until 1911. He intervened with various pretenses in El Salvador, Honduras and Costa Rica. The intervention of the United States and Mexico concluded the war with the agreement that Guatemala, El Salvador, Honduras and Costa Rica should make reciprocal concessions, both commercial and naval, and that the United States and Mexico would settle future quarrels by arbitration. Estrada Cabrera was reelected in 1911 to serve until 1917, and again for the term ending in 1923. In 1920 a revolt against his dictatorship obliged him to relinquish the power to Dr. Carlos Herrera.

ESZTERGOM (German *Gran*, Slavic *Ostrihom*), former residence of the Hungarian kings and seat of the Prince Primate of Hungary, situated near the confluence of the Garam River and the Danube. The cathedral on the castle hill dominates the landscape from a great distance. Begun in 1822, it was completed 1874 in Renaissance style. It is lavishly decorated and has a mortuary chapel of Archduke Charles Ambrosius, Archbishop of Esztergom, by CANOVA, and other chapels and works of art. The palace of the Prince Primate, completed 1882, has a museum of antiques, paintings, and a Dürer collection.

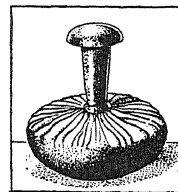
Said to be the Roman *Salva*, Esztergom is considered to have been the cradle of Christianity in Hungary. It was a prominent city in the 10th century. In 900 it became the residence of the Hungarian Duke Geza, whose son St. Stephen was born, baptized and crowned here. With its many palaces and churches, the city is also one of the leading commercial centers in the country. Pop. 1930, 17,360.

ETCHING, a form of engraving in which the lines are bitten by acid into a copperplate. Upon a

plate coated with transparent varnish, or "etching-ground," blackened with smoke, the artist draws with a steel point, or needle, exposing the copper along the lines. He then consigns the plate to a bath of acid, which eats into the copper except where it is protected by the ground, making V-shaped trenches which hold considerable ink. When the faintest lines are sufficiently "bitten," the plate is removed, these lines are "stopped out" with varnish, and the biting resumed. This process of alternate biting and stopping-out is repeated until the heaviest lines, meant to print darkest, are deep enough. The plate is then ready for the printer.

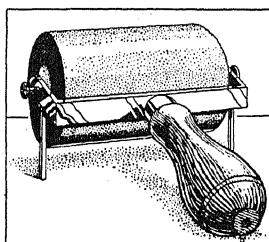
Not only the biting but the inking of a plate requires nice judgment, for which reason the "painter-etcher" does his own printing. The background of an etching is nowhere as white as the paper on which it is printed. That is because a delicate film of ink is left over the copper when it is wiped for the press. This film or tone can be varied at the etcher's will. It need not be uniform over the entire plate. Some of J. M. Whistler's "nocturne" etchings are virtually built up of such tones upon the slightest of outline support. By subtleties of wiping an etcher can obtain from a single plate prints of radically different effect.

If upon pulling a proof, by passing the inked plate and paper through the mangle-like rollers of a copperplate press, the etcher desires to make additions



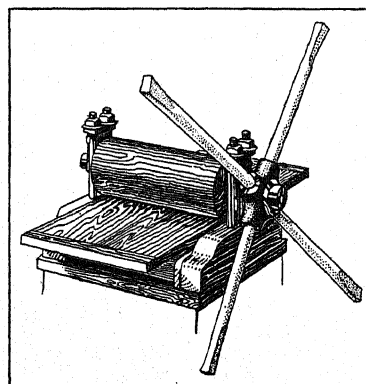
COURTESY F. WEBER CO.

ETCHING-GROUND
IN BALL FORM



COURTESY F. WEBER CO.

RUBBER ROLLER USED IN MAKING
ETCHING PRINTS



COURTESY F. WEBER CO.

HAND-OPERATED ETCHING PRESS

to a plate, he usually does so by using the dry point upon the bare copper. It is successive proofs, with and without alterations, which constitute the "states" of an etching in which collectors are interested.

The etcher's art is one of suggestion and omission rather than of laborious definition. Free, spontane-

ous, individual, it is truly an autographic art. See also PAINTER-ETCHER.

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ETEOCLES, in Greek mythology, son of OEDIPUS and Jocasta. He and POLYNICES, his brother, attempted to rule Thebes alternately, but when the time came for Polynices to rule Eteocles refused to let him. Polynices departed for Argos where he married King Adrastus's daughter. Here the king helped him gather forces to fight Eteocles, and the expedition known as the Seven against Thebes, because the chiefs were seven in number, was fitted out. In the struggle that followed the brothers killed each other.

ETHANE, a gaseous hydrocarbon (C_2H_6) similar to marsh gas. It occurs in natural gas and in crude petroleum. It is colorless, odorless and insoluble. It burns with a pale flame and is explosive when mixed with air. It may be prepared by the reaction of nascent hydrogen on ethyl iodide (C_2H_5I).

ETHANOL, the modern scientific name given in chemistry to the substance (C_2H_5OH) better known as ethyl alcohol, or simply alcohol. Chemically, it may be considered as derived from the hydrocarbon ETHANE, C_2H_6 , the second member of the saturated paraffin series, by the replacing of one hydrogen atom by the hydroxyl group. It can be made synthetically from acetylene, via ethylene and ethyl-sulphuric acid as intermediate products, but it is still almost exclusively obtained from the fermentation of starch and sugars (see ALCOHOL, INDUSTRIAL).

Pure ethanol is a colorless, rather mobile liquid, with a faint, though pleasant, fragrance. Its specific gravity is about 0.79; it boils at about $78^\circ C.$, and solidifies at $-130^\circ C.$, becoming very viscous at about $-90^\circ C.$ Owing to its low freezing point and its large coefficient of expansion, it forms a useful substance for low-temperature thermometers (see THERMOMETER). Alcohol mixes avidly with water in all proportions, thereby contracting and developing heat; it is therefore difficult to keep unadulterated. Really pure, anhydrous or "absolute" alcohol can be prepared from the usual 95% pure commercial product by treatment with quicklime. Ethanol is readily combustible, forming water and carbon dioxide, while burning with a blue flame, and developing an intense heat. It is thus much used as a fuel, convenient also because it leaves no residue. Chemically, it may be oxidized, first to ACETALDEHYDE and finally to ACETIC ACID. With metals, especially the alkalis, alcohol reacts with the formation of alcoholates, such as C_2H_5OK .

The chief application of alcohol derives from the fact that it is an excellent solvent for a large variety of organic substances, FATTY ACIDS, resins, HYDROCARBONS and dyestuffs; all such solutions used medicinally are known as *tinctures*. ALCOHOL is the essential constituent of beer, wines, spirits, liqueurs and all intoxicating beverages used the world over. For the physio-

logical and social effects of this usage and their political consequences, see ALCOHOLISM. W. J. L.

ETHELRED II. See AETHELRED II.

ETHELWULF. See AETHELWULF.

ETHER, a hypothetical medium for the transfer of radiation. Ether, considered as pervading all space, is the transmitting medium for light, electrical disturbances and heat radiation. The theory of the existence of ether provides a basis for the WAVE THEORY of light and an explanation for the propagation of other electromagnetic waves through space. See LIGHT.

ETHER: Discovery of. See MORTON, WILLIAM THOMAS GREEN.

ETHER: Anesthetic. See ETHERS: Diethyl Ether.

ETHEREGE, SIR GEORGE (c. 1636- c. 1691), English dramatist, was born in or near London about 1636. It is supposed that he was educated at Cambridge and afterwards traveled on the Continent. The great success of his comedy, *Love in a Tub*, 1664, introduced him to the dissolute court wits, Sedley, Rochester and others. His gallantries, which included an association with the famous actress, Mrs. Barry, provoked a reputation which long survived his death. In 1667 Etherege produced *She Would if She Could* and *The Man of Mode* nine years later. Subsequent to being knighted, the dramatist is said to have been sent on several diplomatic missions. He was resident-minister at Ratisbon, France, 1686, and died, probably in Paris, about 1691. His three comedies marked the end of the old Jonsonian drama and the beginning of the typical Restoration play of wit and intrigue.

ETHERS, a definite class of organic chemicals which derive their character from a particular molecular grouping of carbon and oxygen. They exist usually as colorless, mobile liquids, although some are gaseous and others solid at ordinary temperatures. Ethers are neutral bodies, slightly soluble in water but readily dissolving in alcohol. They are relatively volatile, due to their low boiling points and low specific heats.

Diethyl ether, $(C_2H_5)_2O$, is commonly known as ether and is the most familiar of the ether series. It is a liquid of a characteristic sweetish odor with a specific gravity of 0.720 at $15^\circ C.$ Ether is soluble in water to the extent of 6.5% at $20^\circ C.$, and is highly soluble in hydrochloric acid. Its boiling point is $35^\circ C.$ and it evaporates rapidly to produce intense local cooling. Upon inhalation, its vapor produces general ANESTHESIA. Ether is very inflammable and readily forms explosive mixtures with air. Caution must, therefore, be exercised against open flames nearby during anesthesia. It is also occasionally administered internally in the form of a spirit.

Other important simple ethers are methyl ether, which is a gas, and isopropyl ether which has a boiling point of $67.5^\circ C.$ Examples of the mixed ethers are ethylene glycol, ethyl ether, which is water-soluble and dissolves nitrocellulose, and methyl phenyl ether or anisole.

A. L. W.

ETHER SPECTRUM. See ELECTROMAGNETIC SPECTRUM.

ETHICS (*tà ethica*, study of *éthos*, character). The moral judgments accepted in a society at any time constitute its view of morality, or in other words, its moral consciousness or conscience. Ethics is the attempt to study morality reflectively, in order to bring its moral judgments into logical consistency with one another or with some established standard, and so to determine their validity. Or if this seems impossible, the student of ethics, otherwise known as the moral philosopher or ethicist, may content himself with endeavoring to discover how moral judgments come to be formulated and modified, and how they are related to other human activities and experiences. The relationship of ethics to morality might be compared with that of grammar and philology to language.

Divisions of Ethics. (a) Comparative Ethics investigates the moral judgments of different historical periods and cultural levels and traces successive stages of human moral evolution. It has assumed importance chiefly since the time of CHARLES DARWIN and HERBERT SPENCER. (b) The oldest branch of ethics is Systematic Ethics, whose origin is usually credited to Socrates. This attempts to discover some supreme standard of good, or *summum bonum*, by which all conduct can be appraised. It also discusses the source in the human mind, such as reason or feeling, by which knowledge of this standard is obtained; what motives and sanctions induce men to follow it; the nature of duty, moral responsibility and the freedom of the will. This side of ethics is the most abstract and theoretical. (c) Investigations of the ethical side of political, social and vocational problems, are respectively known as Political, Social, Professional and Business Ethics. (d) Psychological Ethics investigates those phases of human consciousness and behavior that govern conduct and character. (e) The History of Ethics reviews the interpretations of the past, which until the present century have been chiefly in the systematic and political fields.

Ethics as a Normative Science. Ethics, logic and aesthetics have sometimes been grouped together as normative sciences, which establish standards for the respective values of goodness, truth and beauty. Other sciences are said to be purely descriptive, since they classify events without passing on their desirability or justification. There is a difference in emphasis here between ethics and other social sciences, undoubtedly, but no absolute distinction. No historian, economist, sociologist or psychologist is able to refrain entirely from moral judgments regarding the desirability of the human conduct which he describes. On the other hand, in ethics it is impossible to consider intelligently what men ought to do without inquiring how they actually are mentally and socially constituted, and the range of their capacities.

Moral Evolution. For Comparative Ethics, morality is a function of social organization and develops with it. The social organization of the lowest peoples

is based on kinship. Moral responsibility is collective; blood feuds are common; property, so far as there is any, tends to be held communistically; forms of marriage are diverse, but pair marriage is most common. Morality passes down from one generation to another by unconscious imitation, and with almost no criticism or reflection. The succeeding level finds the various kinship groups submissive to the authority of a ruler or ruling class. This is most frequent in history, in stages of development as far removed as the natives of Dahomey, Ashanti and Uganda and the benevolent despotisms of Louis XIV and Frederick the Great. With the advent of this level, warring clans are forced to submit to royal courts, individual responsibility and private property rights slowly emerge, monogamy usually supplants other forms of marriage.

As increasingly larger areas and populations come under common rule, they are stimulated by the interchange of ideas. Writing and written law develop; the latter becomes reflective. Morality begins to be critical and no longer purely traditional. Civilization begins. After long ages of discipline under Authority, and the attainment of a high degree of culture, peoples sometimes have become capable of obeying and supporting laws and governments of their own choosing. Either in popular assemblies, as in the ancient city states, or through elected representatives, as in modern free national states, they govern themselves. This form of social organization may be called Citizenship. It can only endure provided citizens retain a high sense of civic loyalty and social responsibility. Morality is opened to frank criticism and revision. The danger is that criticism may be hasty and destructive, old moral precepts too quickly rejected, individual lives wrecked by want of moral standards, and communities rent asunder by civil disputes and foreign wars.

Largely for reasons such as the foregoing Citizenship broke down in the ancient world, and a partial reversion to Authority took place under Alexander, Caesar and their successors. Unless our modern national states succeed in developing a morality adequate to settle international disputes as well as internal conflicts between capital, industry and agriculture, Citizenship will again break down; there will either be a reversion to Authority as in ancient times or else the inauguration of some radically new form of social organization, possibly some form of socialism, with a correspondingly new morality. The general course of moral evolution thus far has been one of increasing recognition of the rights of individuals and of a common good. The psychological roots for this have been resentment at injuries stimulating the development of law and justice, and the growth of altruistic sentiment and social consciousness. Biologically, the latter two owe their origin to the maternal and gregarious instincts.

Ancient Systematic Ethics. Although penetrating insight into moral problems was earlier manifested in the literature and legislation of ancient Egypt,

Babylonia, India, China and Israel, systematic ethics had its beginnings in Greece in the time of SOCRATES. In the extensive revolution in laws and customs that had occurred in Athens as a result of the rapid and then unprecedented transition from Authority to Citizenship, many of the younger generation wondered whether any laws and precepts were in truth morally binding, or whether all were the products of superstition or the imposition of selfish interests formerly in control of the state. In opposition to the SOPHISTS, who attacked blind conformity to custom without being able to put a really constructive morality in its place, Socrates sought by informal discussions to establish principles. Every man ought to act in accordance with his own interests, which Socrates probably thought meant in a manner to gain most pleasure for himself; but to succeed in this, a man must be just. It is better to suffer wrong than to do wrong to another, since only the latter can injure one's character. No one does wrong except through ignorance of the real nature of his acts, and of his own ultimate interests. So virtue is knowledge and vice is ignorance. Socrates thought that the real interests of the individual are so completely bound up with those of his city state that he refused to escape illegally from a death sentence legally but unjustly imposed upon him. By this he became the supreme exemplar of a man who died as a martyr to his moral, rather than religious, convictions. He made a profound impression upon antiquity, and all subsequent developments in Greek ethics in one way or another show his influence.

Antisthenes, the founder of the Cynic school, (See CYNICISM.) carried Socrates's ideal of simplicity in living to the extreme of ostentatious poverty. Aristippus, founder of the Cyrenaic school, perverted Socrates's teaching into an ideal of selfish sensuous pleasure. It remained for Plato, youngest but greatest of the pupils of Socrates, and founder of the Academy, to show that morality for that age could best be conceived in terms of Citizenship. In the *Republic*, PLATO describes an ideal city state, in which each class will faithfully perform the functions for which it is best fitted. There will thus be justice in the public life, and corresponding harmony in each individual's soul, as reason rules emotions and appetites. The four cardinal virtues of wisdom, courage, temperance and justice will thus be coordinated, and in his own life each will participate in the eternal and unchanging Idea of the Good, the ultimate reality. ARISTOTLE, greatest of Plato's pupils, and founder of the Lyceum, also thought of morality in terms of Citizenship in a free state. Ethics is accordingly a branch of Politics. Virtue, for him, unlike Socrates and Plato, is not merely a matter of knowledge of one's own ultimate interests; it further implies training and experience. Moral virtues are settled habits of deliberate purpose; most of them occupy a golden mean between opposite vices. For example, courage stands between rashness and cowardice, the precise point in the case of any individual depending upon

his responsibilities and capacities. Highest of all are the dianoetic or intellectual virtues. For example, the life of a scholar passed in disinterested study (*theoria*) is best and happiest and most like that of the gods.

The Hellenic, or purely Greek, period ended with Aristotle. It was followed by the Hellenistic period, with partial reversion to Authority. Since men were no longer free citizens with civic rights and responsibilities, after the conquests of Alexander the problem for all schools became more individualistic. How can a wise man, dependent chiefly upon his own resources, attain his highest good? EPICURUS and his followers answered, by cultivating happiness in inward peace of mind, surveying external events over which he has no control with imperturbability, and finding joy in friendship and a simple but not ascetic life. The Stoics said that the wise man will render himself absolutely free from all desires and emotions, so that no outward misfortunes will greatly concern him, since they cannot affect his character. Originally harsh, stern and fanatical, as depicted by Zeno, Cleanthes and Chrysippus, the Stoic ideal became mollified in later, and especially Roman imperial, times. It is found in combination with elements from other schools in writers like CICERO, SENECA, EPICTETUS and MARCUS AURELIUS. Mercy, kindness and justice are emphasized in later Stoicism; all men are expressions of the universal reason (*Logos*), brothers, children of a common Father. Men should conceive themselves as citizens of an ideal state; for the world is one city of gods and men. The Sceptics doubted the possibility of certain knowledge on ultimate problems; holding that when possible, one should avoid committing oneself; or if necessary to do so, take the course most favored by probability. Neo-Platonists, founded by Plotinus, inclined toward asceticism and sought a higher moral life through mystical absorption in the Deity.

Christianity. It was as a religion rather than a movement in systematic ethics that Christianity began. New Testament morality emphasizes love (*agape*) to an extent unknown to pagan Greeks and Romans, insists on purity in family and sex relations, deepens the sense of moral inwardness by insisting upon a spiritual rebirth, develops moral unity through membership in the "kingdom of heaven" or church, and seeks to accomplish all these benefits through a close mystical union with Christ. While traces of systematic ethical thought appear in some church fathers, notably Augustine of Hippo, it was not until the revival of the study of Aristotle in the Middle Ages that the church seriously attempted to assimilate the best of Greek systematic ethics and incorporate in it Christian theology. This was most successfully done by THOMAS AQUINAS, who largely accepted the ethics of Aristotle, but supplemented his deficiencies by religious amendments. The supreme good of man is God; in knowing and loving Him is highest happiness. Ultimate moral principles rest on Eternal Law, known to the Divine Reason. Eternal Law with reference to a specific creature becomes Natural Law, which bids men "to preserve their own life, and to

ward off its obstacles . . . to know the truth about God, and to live in Society." By means of a special natural faculty (*synderesis*) we know the ultimate, universal and immutable moral principles. Our reason applies these principles to particular cases by an act of conscience. The deficiencies of human reason are largely corrected by Divine Law, chiefly the revelations of God to men in the Bible. Human Law consists of deductions or applications made by rulers for the common good.

Roman Catholic moral philosophers continue in the main to adhere to the basic principles of Christian ethics laid down by St. Thomas Aquinas. All conduct should be subordinated to the supreme end of knowledge and love of God; so all modern attempts to divorce ethics from theology and base it on reason, perfection, duty, happiness, or other non-religious principles, are repudiated. This explains Catholic insistence that schools ought to be under ecclesiastical control; unless based on Catholic theology, moral instruction is inadequate.

During the Reformation, Protestant leaders were busied with reforms in life and conduct, the restoration of Christian precepts and practices to New Testament simplicity. So they had little time for systematic ethical theory. In view of the diversity of Christian sects and the increasing number of sceptics, it became clear to most of the philosophers of the Enlightenment, about 1690-1781, that ethics must furnish its own foundations for morality, independent of theology. This is necessary to justify religious toleration, for one thing; it must be shown that a change in a man's religious beliefs does not necessarily imply refusal to recognize moral obligations. So, beginning with Shaftesbury, modern ethics has assumed a secular basis. The present Protestant attitude is friendly toward modern secular ethical systems, so far as their teachings do not contradict the morality of the Gospels. All true ethics is believed to be in harmony with Christianity; the latter need not fear honest inquiry into the ultimate principles of morality, even though conducted independently of theology.

Modern Systematic Ethics. Most of the principal modern systems may be brought under the following classification. 1. Intuitionism (*See INTUITION.*) maintains that the source of moral judgments is a kind of direct intuition; the mind perceives the distinction between good and evil as directly as that between blue and yellow, identity and difference, although it is not always able to discriminate individual cases so clearly. Francis Hutcheson thought that moral perception is the work of a special moral sense. Butler, Reid, Stewart, Brown and others attributed this perception to conscience. All of this school believes that most of the content of morality can readily be discriminated by an intelligent and experienced conscience. IMMANUEL KANT is usually classified as an Intuitionist. In his form of the doctrine the trained mind can intuitively perceive the truth of a universal formula applicable to every possible circumstance that involves a moral issue. This formula, "the categorical

imperative," Kant attempted to state in various ways. The simplest version of it is, that every human being should regard himself and every other person as an end for the performance of duty, and not as a means to the enjoyment of pleasure; in other words, every human being has a moral worth and dignity which he and all others must respect. Intuitionists emphasize the importance of right motives and are comparatively indifferent to consequences. One should do right simply because it is right. Let justice be done, though the heavens fall. 2. Teleological Systems (*See TELEOLOGY.*), on the contrary, maintain that the rightness and wrongness of actions cannot be known intuitively, but are learned by consideration of desirable and undesirable consequences. (a) Ethical Hedonists (*See HEDONISM*) (it is important to distinguish Ethical Hedonism from Psychological Hedonism to be mentioned below) maintain that all desirable consequences of conduct are ultimately reducible to the maintenance of pleasure and diminution of pain. THOMAS HOBBS and a few other Egoistic Hedonists claim that each individual aims exclusively at his own pleasure and pain; if every one always acted for his own interests in the long run, this would be a much better world for all. Most Ethical Hedonists, on the contrary, have been Utilitarians, (*See UTILITARIANISM*) and have maintained that the criterion of good is the greatest happiness, i.e., pleasure, of the greatest number, and that each should count for one, and none for more than one. JEREMY BENTHAM, the first unqualified Utilitarian, and James MacKaye, a contemporary Utilitarian, claim that pleasures and pains can be measured quantitatively. John Stuart Mill, on the contrary, made pleasures different in quality as well as quantity. Henry Sidgwick, the profoundest thinker of the school, makes some concessions to Intuitionism. Herbert Spencer supported Utilitarianism from the standpoint of evolution. All Hedonists agree that virtues and duties are of purely instrumental value; they are good because their possession and practice increases the total amount of pleasure in the world; otherwise they would be bad. (b) Teleological systems which reject Hedonism have received various names. Eudaemonism, Self-Realizationism and Perfectionism are perhaps most common. These all agree that the good is a composite of many values of which pleasure is not the most important. A convenient table proposed by W. G. Everett lists these values as economic, bodily, recreational, societal, personal, aesthetic, intellectual and religious. No life can be regarded as well rounded in which any of them are omitted, but the relative emphasis will be different as persons vary in temperaments, talents, vocations and avocations. Virtues are of intrinsic value. The majority of moral philosophers since 1800 can be listed under this general head, among whom mention may be made of GEORG HEGEL, T. H. Green, F. H. Bradley, F. Paulsen, J. S. Mackenzie, Hastings Rashdall and JOHN DEWEY. The philosophers mentioned differ greatly in details. Some important modern philosophers are either too eclectic or too unique to be brought readily under the

above classification, *e.g.*, Spinoza, Hume, Adam Smith, Schopenhauer and Nietzsche.

Present Tendencies. Some present writers include ethics within a larger study of values, including beauty and sometimes truth, as for example, W. M. Urban, R. B. Perry, D. H. Parker and A. P. Brogan. E. Westermarck, L. T. Hobhouse and others have approached ethics chiefly from the standpoint of evolution and regard the traditional issues between the systems as of minor importance. The French sociological school, Durkheim, Levy-Bruhl, Bayet and others, believe that attention ought to be centered wholly on Comparative Ethics, and until more complete knowledge of the history of moral judgments and conduct is available that the discussion of ultimate criteria is futile. Students of Psychological Ethics are now interested in tracing the development of character from native instincts and acquired habits.

Most now agree that pleasure is an accompaniment of organic and mental processes directed toward ends and not their direct object; we feel pleasure because we are successful or anticipate success in attaining objects desired, and not the reverse. This is a refutation of Psychological Hedonism, the doctrine that the immediate desire of men is always for pleasure and immediate aversion always from pain, a doctrine advanced by Bentham and Mill as a proof of Ethical Hedonism. The latter must therefore be established by Utilitarianism in some other way, if it is possible to establish it at all. Recent developments in abnormal psychology show that suppressed wishes, abnormal secretion of glands and other mental and bodily conditions are responsible for much misconduct formerly attributed to moral perversity. It is more important to establish favorable mental, bodily and social conditions than to debate on the metaphysics of the freedom of the will. Political Ethics now teaches that while corrective justice, that is, punishment of criminals, finds its original motive in resentment, mere retribution is not a sufficient justification.

Some further moral ground must be established, as moral education of the public, deterrence of others from committing like offenses, prevention of further wrongs by the offender, or reformation of the offender himself. Other problems much discussed are the question of the completeness of the sovereignty of the state, the rights of minorities including conscientious objectors, what grounds justify war, if any, and the respective merits and possible reconciliation of nationalism and internationalism. The problems of Social Ethics can mostly be brought under the general head of distributive justice. In our modern society, with its great wealth and culture, why are opportunities so unequally distributed? How can individual liberty and initiative be fostered, and more approximate equality of opportunity at the same time afforded to all? The respective merits of capitalism and the various forms of collectivism are critically evaluated in this connection. In Professional and Business Ethics, the chief problem is, what principles should guide those in each vocation in their relations to one another,

their patrons, their employees and the public? Codes have been drawn up and to some extent enforced by many professional and business men's associations, and a remarkable intensification of moral consciousness and consequent development of ethical principles is now taking place.

W. K. W.

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ETHIOPIA, or **AETHIOPIA**, a country of Africa, now corresponding roughly to **ABYSSINIA**. Extending from Khartoum northward to Egypt, it ranged southwest as far as was known in ancient times. Its civilization was copied somewhat from that of Egypt, the religion and language strongly resembling those of the more fertile Nile Valley. *Amen* was the chief god and temples were erected to his worship, the most important one being at Napata, at times the capital city. Politically Napata was replaced by Meroe, but the former city never lost its importance as the religious center of the country. At one time Ethiopia was a province of Egypt but it later became independent and even conquered Egypt for a period. Under Petronius, in 24 and 23 B.C., the Romans penetrated the country, using it for military establishments. These were later abandoned, however, and nothing fruitful came of them.

ETHIOPIC LANGUAGE, a **SEMITIC** language of the South **ARABIC** group, also called **Ge'ez**. Its alphabet consists of 26 consonants or syllables written from left to right, each having seven different forms indicating one of the seven vowels.

The verb in this language has four forms—simple, causative, reflective-passive and causative-reflective—from each of which a simple, intensive and frequentative are built. There are two tenses, perfect (completed action), and imperfect (incompleted action, cf. **ASPECT**); two moods (indicative and subjunctive); and an imperative in the second person. The noun distinguished two genders (masculine and feminine) and two numbers (singular and both "sound" and "broken" plurals, as in Arabic). Ethiopic has no article and, like all the Semitic languages, it makes extensive use of the construct case. Ethiopic was spoken in Abyssinia by Arabs who migrated there from Arabia a few centuries before the Christian Era, but in the Middle Ages it disappeared in favor of Tigrē, Tigrīña and Amharic (*see* articles under these titles), though it is still used as the language of the Church.

I. M.

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ETHIOPIC LITERATURE. The literature of Ethiopia, or Abyssinia, is said to exist only after the introduction of Christianity into the country (4th-7th centuries). The translation of the Ethiopic Bible, written chiefly in the ancient **Ge'ez** language, was made in this period. Little of interest survives from

the pre-Christian era. Some Christian apocryphal works exist in Ethiopic, among them a version of the book of *Enoch*, of *Jubilees*, *The Life of Adam and Eve*, *The Ascension of Isaiah*, *The Apocalypse of Ezra* and *Maccabees*. St. Frumentius, or Abba Salama, called "The Apostle of Ethiopia" for his evangelization of the country in the 4th century, is sometimes considered the translator of the Ethiopic Bible.

Other outstanding works of the Ethiopian literature are lives of saints, especially in the collection called *Synaxar*, miracles, chronicles, religious romances, hymns and prayers. A version of an Arabic code of law used in Abyssinia exists, and also two histories, the *Kebra Nagaset*, a legendary account of the Axumite kingdom, and the *Tarek Nagushti*, a chronicle history of kings. In general, the literature of Ethiopia is unimportant in the modern sense of the word, but remains a field of research in versions of the Bible.

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ETHNOLOGY, a division of anthropology, usually limited to the study of living peoples, particularly their mode of life, arts and beliefs. More than a century ago it was conceived that the origin and career of prehistoric and primitive peoples in different parts of the world might be revealed by a comparative study of their ways of living. Thus, in the study of primitive peoples careful compilations of data are made, showing what kinds of tools they use, how they build their houses, prepare their food, regulate their family life, dispose of their dead, and what they believe regarding the soul. In large part, ethnology is a descriptive science, but it has developed some theoretical interpretations for social customs and beliefs as expressed in explanation of such phenomena as **TOTEMISM**, promiscuity and marriage, and magic and Animism, for details of which the reader should turn to the special articles on those subjects. In the article **ANTHROPOLOGY**, the relation of ethnology to other phases of the science of man is treated at length. The tendency among American scholars is to regard ethnology as the study of primitive culture. C. W.

ETHYL ACETATE, or acetic ether, the name given to the ester formed by the interaction of ethyl alcohol and acetic acids; its chemical formula is $\text{CH}_3\text{COOC}_2\text{H}_5$. Commercially, it is prepared from absolute alcohol and sulphuric acid and subsequent action of the ethyl sulphate thus formed with fused sodium acetate. It is obtained directly from aluminum alcoholate and acetaldehyde in the presence of anhydrous aluminum chloride or a similar substance, to absorb the water formed by the reaction. Since ethyl acetate slowly saponifies in the presence of water, yielding ethyl alcohol and acetic acid again until an equilibrium is reached, the crude commercial product has to be purified and freed from water by distillation over calcium chloride or anhydrous carbonate of potash. Ethyl acetate is a colorless liquid with a

very pleasant odor; specific gravity, 0.92; boiling point, 77°C . It is soluble in water up to 1 part in 8; conversely, water is soluble in ethyl acetate up to 1 part in 26. It is widely used as a solvent for **CELLULOSE**, resins, camphor, tannin and dyes; it is also used in **LACQUERS**, perfumery and liqueurs. W. J. L.

ETHYL ALCOHOL. See **ETHANOL**.

ETHYL CHLORIDE, a colorless, volatile liquid with a sweet, agreeable odor and taste, known also as monochloromethane, having the formula $\text{C}_2\text{H}_5\text{Cl}$. It is a gas at ordinary temperature and pressure possessing an ester-like odor. As a liquid it boils at 12.2°C . It is somewhat inflammable and is poisonous after prolonged exposure. It reacts with compounds which will replace the Cl atom, as bases and salts of organic acids or alcohols. It also reacts with compounds which will replace the H atoms, as Cl_2 , Br_2 , HNO_3 , etc.

Ethyl chloride is manufactured by two general methods: (1) the interaction of ethyl alcohol (see **ETHANOL**) and hydrochloric acid in aqueous solution, in the presence of CaCl_2 , ZnCl_2 or FeCl_3 at 80°C ., and (2) by the addition of hydrochloric acid to **ETHYLENE** in the presence of a catalyst as AlCl_3 or BiCl_3 at a temperature of 160°C . either at normal or elevated pressure. The first method has been modified to carry out the reaction in the gaseous phase. Ethyl chloride is generally purified by distillation.

Ethyl chloride is used as a component of fluid for refrigerating machines, and as a reactant for dye intermediates as diethyl aniline. It is also used as the source of the ethyl group in lead tetraethyl by interaction with sodium-lead alloy.

Medicinally, ethyl chloride is used in the form of a spray to produce local anesthesia by freezing in minor operations. When inhaled, it produces prompt **ANESTHESIA**, but has many of the same dangers as **CHLOROFORM**. E. C. B.

ETHYL COMPOUNDS in organic chemistry are that important class of substances containing the alkyl group or radical C_2H_5 or CH_3CH_2 , which though unable to exist by itself, can yet be manipulated with ease in chemical reactions, preserving its identity, and acting as a single, stable group. Among the most important compounds are ordinary or ethyl alcohol, $\text{C}_2\text{H}_5\text{OH}$ (see **ETHANOL**), ether, $(\text{C}_2\text{H}_5)_2\text{O}$ (see **ETHERS**), ethyl chloride, $\text{C}_2\text{H}_5\text{Cl}$, a very volatile, colorless, pleasant smelling liquid used as a mild anesthetic, especially in dentistry, and ethylamine, $\text{C}_2\text{H}_5\text{NH}_2$, found in small quantities in coal tar and a putrefaction product of nitrogenous organic substances. The addition of one atom of hydrogen to the ethyl group transforms it into **ETHANE**, a stable compound, and the second lowest homolog in the paraffin series of hydrocarbons, of which **METHANE**, CH_4 is the simplest representative.

ETHYLENE, a colorless hydrocarbon gas, having a faint pleasant odor. Corresponding to its molecular formula of C_2H_4 , its vapor has a density only slightly less than air. The boiling point of ethylene is

—103.9° C. and it can be condensed to a liquid which has a pressure of 744 lbs. per sq. in. at its critical temperature of 32.1° C. Chemically, ethylene is an unsaturated compound of the olefine series and is quite reactive. It burns readily with a luminous flame and can be exploded with air or oxygen.

As a general constituent of coal and oil gases, ethylene indirectly serves as a fuel, but perhaps its most important use is found in the synthesis of a large variety of organic chemicals including ethyl alcohol (*see* ETHANOL), ether (*see* ETHERS), and ethylene glycol. It accelerates certain vegetative processes and is widely used for coloring and ripening such products as oranges, bananas and tomatoes. A mixture of ethylene and oxygen is used as a general anesthetic.

ETHYLENE ANESTHESIA. Ethylene gas, as a chemical compound has been known since 1779. On the basis of its toxic action on carnation buds and flowers, Luckhardt and Thompson (1917) tested out its poisonous action upon animal life. It was soon shown by them that, instead of being toxic, its inhalation deadened every sensation including pain; in fact, its inhalation produced, in a given concentration, a condition of sleep not unlike normal sleep. Under its influence animals could be subjected to discomforts unaccompanied by the usual painful sensations. Having corroborated these findings on the usual laboratory animals, including the dog, Luckhardt and Carter (1923) tested out ethylene gas with oxygen upon themselves and a number of associates. Following the inhalation of a mixture of 80% ethylene and 20% oxygen, sleep ensued in 45 seconds to one minute, accompanied by a relaxation and an insensitiveness to pain which suggested that in this or slightly higher concentration the gas might be useful as an anesthetic agent. Within a few weeks after this demonstration, several operations were performed on human subjects with excellent results. Luckhardt and Dean Lewis (1923) studied its effects in some 900 operations prior to a report on its advantages in surgical maneuvers and on its shortcomings. On the basis of this clinical study, ethylene anesthesia was introduced into surgical practice and its advantages over ether, nitrous oxide, and especially chloroform were soon established by numerous investigators. To date, this form of anesthesia has been found practical in infants five days old and in adults aged ninety. The action is nearly as profound as that of ether. Whereas it has all the advantages of ether, its inhalation neither irritates the respiratory passages nor does it cause post-operative gas pains or prolonged postoperative nausea and vomiting. It has been used satisfactorily as an anesthetic agent here and abroad in millions of anesthetics. In fact, under proper condition of administration, it has been acclaimed by many as the anesthetic agent of choice.

A. B. L.

ETIQUETTE, a word still used in the French language to signify a label or stamp, and now in English usage the term for the established and accepted rules of social, business and professional conduct. Etiquette may constitute only the observance

of good manners or it may include a long program of state ceremonials. Its form varies greatly according to country and race, and what may be correct in one country may be incorrect in another.

BIBLIOGRAPHY.—Emily Post, *Etiquette in Society, in Business, in Politics and at Home*, 1928.

ETNA, a borough in Allegheny Co., southwestern Pennsylvania, situated on the Allegheny River, 2 mi. north of Pittsburgh and served by three railroads. It is one of the leading industrial suburbs of Pittsburgh, with large iron and steel mills. It also has various other manufacturing plants. Natural gas from some distance was piped into the town in the early days to be used industrially. The first manufacturing began about 1820. Pop. 1920, 6,341; 1930, 7,493.

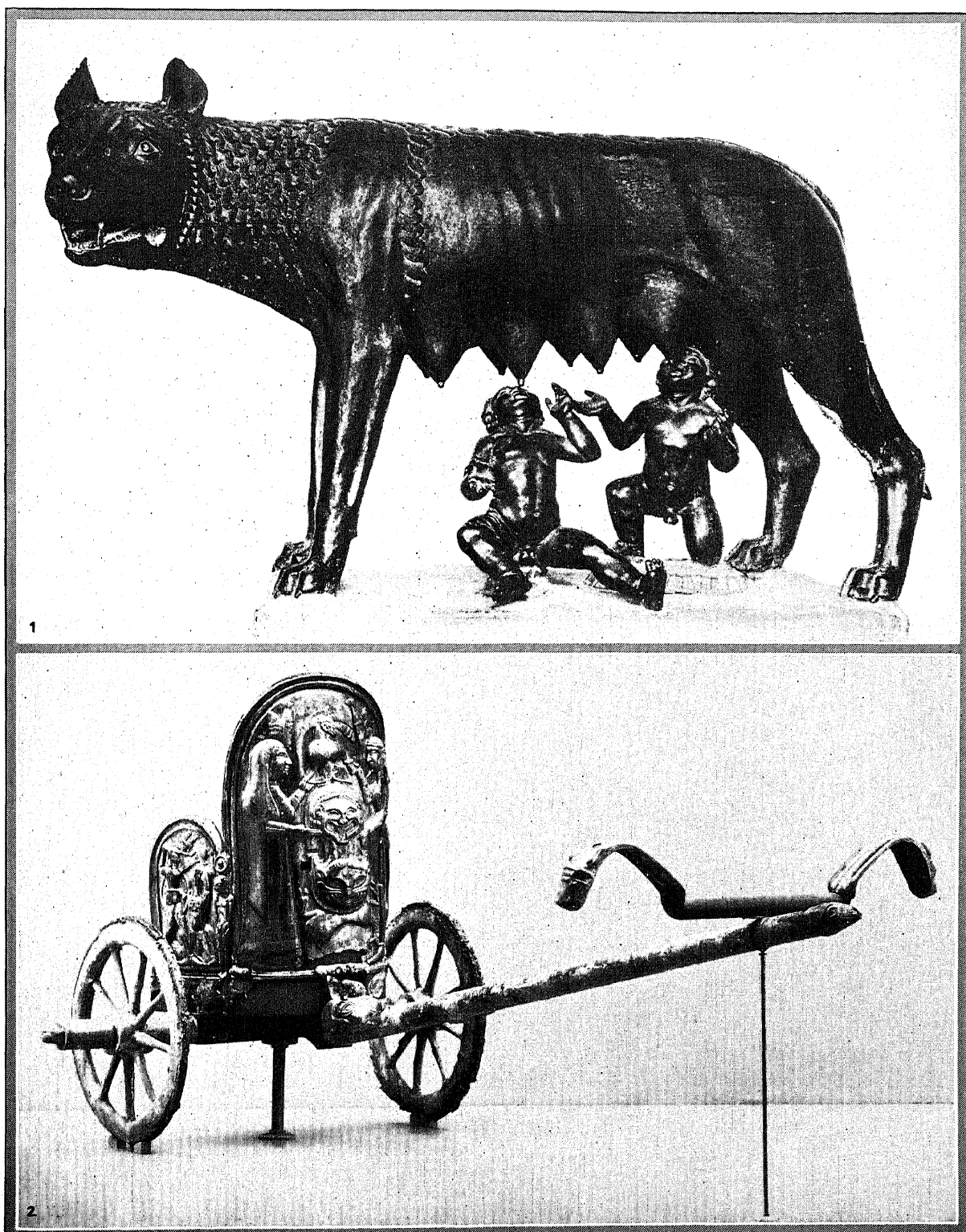
ETNA, MOUNT. *See* **ÆTNA**.

ETON, a town of Buckinghamshire, England, on the Thames across from Windsor, 22 mi. west of London. The celebrated college, founded and endowed by Henry VI in 1440, is now the largest of English public schools. Its buildings, largely of mellowed brick, were completed in 1523, and in 1889 and 1908 new groups were opened. Two quadrangles, the larger of which is the school yard; a memorial to 1,157 old Etonians perished in the World War; the splendid library containing many priceless items; the Early English chapel; and the playing field are particularly celebrated. The main body of scholars, averaging 1,100, are known as oppidans as distinguished from the smaller group of collegers, who hold scholarships. The oppidans wear the characteristic tall hat, wide collar and short jacket. Pop. 1921, 3,369; 1931, 2,005.

ETON COLLEGE, a celebrated boys' school, situated at Eton, opposite Windsor, Buckinghamshire, England. Largest of the ancient public schools in England, it was founded in 1440 by Henry VI, being named the College of the Blessed Mary of Eton. The first and second provosts were respectively Henry Sever and William of Waynflete. From the beginning Eton has maintained a connection with King's College, Cambridge. The students of Eton are mainly sons of the gentry or nobility whose names are entered at birth. The students number about 1,100, of whom the majority are house residents. In 1931 the headmaster was Rev. C. A. Alington. *See also* HARROW SCHOOL; RUGBY SCHOOL; WINCHESTER COLLEGE.

ETRURIA, or Tuscia, a country in ancient Italy, bounded on the east by the Tiber and the Apennines, on the west by the Mediterranean, and on the north by the valley of the Arno. The inhabitants, known as Etruscans, were of uncertain origin. Herodorus supposes them to have been emigrants from Ionic Greece which is likely because of their artistic ability, maritime power and mystic religion. Beginning in 1044 B.C., the confederation of cities they founded in Italy proved them superior to their primitive neighbors. Some of their customs were later adopted by the Romans. Religion was important in their lives and, like other ancient races, they set great store by the ceremonial burial of the dead. It is from

ETRUSCANS



2. COURTESY METROPOLITAN MUSEUM OF ART

ETRUSCAN ART OF THE FIFTH AND SIXTH CENTURIES B.C.

1. The Capitoline Wolf with the twins, Romulus and Remus, a work of the 5th century B.C. It is said that the wolf first stood in the Capitoline Temple, Rome. 2. Etruscan bronze biga, or two-horse chariot, of the 6th century B.C. The guard, hubs and yoke are all of repoussé work—hammered bronze.

inscriptions and objects found in tombs that modern civilization derives its knowledge of the Etruscans. The jewelry thus recovered is of a fine craftsmanship, and the pottery, by its quantity, suggests that ceramics was a national art. In 280 B.C. the last Etrurian stronghold, Volaterrae, surrendered to Rome, but though the people became subject to the Romans, they were long in relinquishing national customs. Rome showed respect for them, and a number of famous men in the late Republic and the Empire were proud of their Etruscan descent.

ETRUSCAN LANGUAGE, an extinct language of the ancient Italian Etruria and preserved in over 8,000 inscriptions, mainly from the last quarter of the 7th to the second half of the 2nd century B.C., and in the wrappings of an Egyptian mummy in the museum at Zagreb, Yugoslavia. Written from right to left in an alphabet derived from Greek, some 90% of the texts are epitaphs containing little but proper names; only five are of any length, the mummy-wrapping, by far the most extensive, having about 1,200 words. In the absence thus far of any bilingual text of importance, the linguistic affinities of Etruscan remain unsolved. The meaning of only a few words is definitely known, and the inflection is wholly problematic. The language is generally supposed to have come from Asia Minor, and possibly finds cognates in the equally obscure LYDIAN and LEMNIAN. Attempts to connect it with Indo-European, Caucasian, Sumerian (see articles under these titles), or now vanished languages of the Alpine area can scarcely be deemed successful. In addition to several loan-words, Etruscan gave LATIN a large number of personal names and, possibly, a strong stress-accent on the first syllable as contrasted with the free accent of Indo-European.

L. H. G.

BIBLIOGRAPHY.—*Corpus inscriptionum Etruscarum*, 1893; G. Pontrandolfi, *Gli Etruschi e la loro lingua*, 1909; E. Fiesel, *Etruskisch*, 1931.

ETRUSCANS, an ancient people, of mixed origin, who inhabited a number of federated cities in northern Italy, especially the district now called Tuscany (ancient Etruria). They achieved distinction as seamen, both pirates and traders, at an early date, and had a colony in Corsica. Their relations with the Carthaginians were friendly, resulting in an alliance to expel the Greek colonists from the west; but their combined fleets met a serious defeat at the hands of Hiero, Lord of Syracuse, off Cumae, 474 B.C. Possibly consequent upon this they sent a contingent to assist the Athenian expedition against Syracuse during the Peloponnesian War, 414 B.C. By 400 B.C. the period of their greatest power had waned; attacked by the Gauls from the north, Samnites and later the Romans from the south, they lost all their territory save Etruria. During the 6th century B.C., when they were strong, they had included the city of Rome within their federation, as the legends concerning the two Tarquins, Kings of Rome, and the typical Etruscan architecture of the Capitol and the Cloaca Maxima, bear witness. But as their dominion contracted,

Rome fell away from them and becoming implicated with the Latins regarded the Etruscans with hostility. In a struggle beginning with the fall of Veii, 393 B.C., and ending with the battle of Vadimonian Lake, 282 B.C., the Etruscans were slowly conquered by Rome. They were apparently admitted to Roman friendship and alliance, and in 89 B.C. received Roman citizenship. They long retained their marked national characteristics, and indeed Roman religion, ceremony, art and institutions contained definite traces of Etruscan origin.

ETTRICK SHEPHERD, THE, an outstanding character in the *Noctes Ambrosianae* by "Christopher North" (see WILSON, JOHN). He is an idealized portrait of JAMES HOGG, the Scotch poet, who in his youth had been a shepherd in the Ettrick Forest.

ÉTUDE, literally, in French, a study or exercise. In musical usage the word is applied to a solo composition, usually but not necessarily instrumental, which is designed at once to increase and to exhibit dexterity, although composers often adopt the name for works having as much musical interest as technical value. Preeminent among these are the 27 pianoforte études of FREDERIC CHOPIN; the 12 *études d'exécution transcendante* of FRANZ LISZT.

ETYMOLOGY, the study of the history and determination, so far as possible, of the origin of a word or group of words, or of a DETERMINANT or INFLECTION. In such study, a word is analyzed into its components, and, in rigid conformity with Phonetic Law, as many cognates are sought in as many related languages (cf. FAMILY, LINGUISTIC) as possible, each of these cognates being similarly analyzed. In addition to the purely phonetic correspondences, the meaning of each cognate or supposed cognate must be considered (see SEMANTICS); for if these meanings cannot be reduced, when every semantic possibility has been weighed, to a common basal signification, the etymology must be discarded, no matter how satisfactory it may be phonologically and morphologically. In this way each word whose etymology can be established is reducible to a BASE, and very frequently its evolution of meaning can be traced simultaneously. There are, however, a vast number of words whose fundamental meaning has been lost; further difficulty lies in the fact that bases are often homonymous, i.e., of identical form, but different meaning, so that a given word may equally well be traced to either of them, in which case the etymology is termed "ambiguous"; and many words are so isolated that reduction to a base gives no intelligible result, in which case their etymology is termed "unknown."

L. H. G.

EUBOEA, also Negroponte, the largest Greek island in the Aegean Sea. It lies along the coast of Attica and Boeotia and is separated from the mainland by very narrow passages. The island measures 90 mi. in length and varies in width from 4 to 30 mi. The surface is mountainous, broken by fertile valleys. The highest point of land is the peak of Mt. Delphi, 5,725 ft. above sea level. Agriculture, live stock breed-

ing, mining and fishing are the main industries. The principal minerals are coal, magnesite and marble. Grain and various fruits, including olives, are the agricultural products. The island constitutes a department of the Greek republic. Chalcis, pop. 1928, 17,297, is the capital. Pop. 1928, 154,449.

EUCALYPTUS, an important genus of trees of the myrtle family, comprising about 300 species chiefly native to Australia with a very few in the Malayan region. Many species, commonly called gums, yield valuable woods; others are widely planted in warm countries for street trees and quick timber. They are mostly trees of unusual appearance, giving a characteristic aspect to the forests which they dominate. The rigid, leathery leaves often hang obliquely on their stalks with their edges placed vertically to the sun. Some are exceedingly rapid growers, and attain immense size, the king gum (*E. regnans*), reaching a height of 326 ft., with a girth of 25 ft. at 6 ft. from the ground. Various species produce kino, sugar, tanning material and eucalyptus oil.

Upward of 70 species are planted for ornament in California and the Gulf states, the best known of which is the BLUE GUM (*Eucalyptus globulus*).

EUCHARIST, an ecclesiastical term, derived from the Greek and signifying great joy. It is applied, especially in Catholic churches, to the Lord's Supper, or ministration of bread and wine as the Communion of the Body and Blood of Christ. In the Catholic Church, the eucharist is known as the sacrament and sacrifice of the Mass.

EUCHARISTIC CONGRESS, an annual convention participated in by Roman Catholic ecclesiastics and laity in honor of the Sacrament of the Body and Blood of Christ and to set forth the teaching of the Church on the Holy Eucharist. The idea of a Eucharistic Congress was of French origin. The first, held at Lille, France, in 1881, was purely local in its composition; so also were the second, at Avignon, in 1882, and the third, at Liège, in 1883; but the fourth, held at Fribourg in Switzerland, in 1885, was a larger gathering, and the fifth, which met at Toulouse, in 1886, was attended by 1500 clergy and 30,000 laymen. The Congress gradually became an international gathering, attended by papal delegates, prelates, and priests from all over the world and attracting the laity by the tens of thousands. Not only Roman Catholic countries but England, Australia, Canada, Ireland and the United States have been the scenes of these Congresses. With elaborate ceremonies and the employment of ecclesiastical pageantry, the Congresses have served to stimulate the fervor of the participants and to display to others the importance of Eucharistic faith and practice in the Roman Catholic Church.

EUCKEN, RUDOLPH CHRISTOPHER (1846-1926), German philosopher, was born at Aurich, Jan. 5, 1846. At Göttingen he studied under RUDOLF LOTZE and at Berlin under Trendelenburg, both of whom greatly influenced his later thought. He became professor of philosophy at Basle, and at Jena from

1874-1920. Eucken was a prolific writer. Among his works translated into English are the following: *The Problem of Human Life*, 1909; *The Truth of Religion*, 1901; *Life's Basis and Life's Ideal*, 1912, and *Main Currents of Modern Thought*, 1912. Eucken's chief interest was religious. His philosophy is a spiritualistic idealism emphasizing the reality and worth of the inner life. In 1908 Eucken was awarded the Nobel Prize in literature. He died Sept. 15, 1926.

EUCLID or **EUCLIDES** (c. 280 B.C.), Greek mathematician, who flourished around 280 B.C. The place of his birth is uncertain. He taught mathematics at the ALEXANDRIAN SCHOOL and belongs to the period of the Ptolemies. He is remembered for his *Elements*, a treatise on geometry, originally consisting of 13 books. Throughout the centuries Euclid has been the standard text. He did for geometry what Aristotle did for formal logic. Other systems of geometry have appeared but with the axioms and postulates with which he started, Euclid perfected his system to such a degree that but little improvement has been made since his time. He also wrote a treatise on optics and one on harmony.

EUCLID, a suburban village of Cuyahoga Co., Ohio, on Lake Erie, about 10 mi. northeast of Cleveland. It is served by the New York Central and the Nickel Plate railroads. Euclid has growing industries, manufacturing chiefly machine and foundry products, brass, metal stampings and addressographs. The retail trade in 1929 amounted approximately to \$3,190,000. CHARLES BRUSH, inventor of the arc-light, was born in Euclid. The village of Euclid was incorporated in 1903. Pop. 1920, 3,363; 1930, 12,751.

EUCLIDEAN GEOMETRY examines the properties of space relationships assumed to exist from actual experience and as developed by Euclid in his *Elements*. One of its main characteristics is seen in the definition of parallels, which states that two parallel lines can never intersect and in the postulate that through a given point only one line can be drawn parallel to a given line. See GEOMETRY; NON-EUCLIDEAN GEOMETRY; AXIOM; POSTULATE.

EUFULA, a city in Barbour Co., southeastern Alabama, on the Chattahoochee River, about 75 mi. southwest of Montgomery. River craft and the Central of Georgia Railroad afford transportation. In the surrounding region are pine forests and bauxite is found. The principal crops are cotton, corn and peanuts. Eufaula is a shipping center for the agricultural products, and manufactures cloth, rope, barrels, underwear, rayon and fruit baskets. Pop. 1920, 4,939; 1930, 5,208.

EUGENE, a city in western Oregon, the county seat of Lane Co., situated at the head of navigation on the Willamette River, 125 mi. south of Portland. The Southern Pacific Railroad, the Oregon electric railway, river craft and an airport serve the city. Hay, grain, wool, fruit and vegetables are among the products of the region, and there are valuable tracts of timber nearby. The city is a shipping center for lumber, and

has woolen mills, canning factories and railroad shops. In 1929 the manufactures amounted approximately to \$5,000,000; the retail trade reached a total of \$16,264,425. It is the seat of the University of Oregon. Eugene was settled in 1854, founded by Eugene Skinner. Pop. 1920, 10,593; 1930, 18,901.

EUGÈNE DE SAVOIE-CARIGNAN, PRINCE (François Eugène) (1663-1736), Austrian soldier and general, was born at Paris, Oct. 18, 1663. His efforts to enter the French Army in youth were blocked, and he joined the Austrian army in 1683. His prowess at the siege of Vienna (1687), Belgrade (1688), and Mainz (1689), won him quick promotions. When war was declared between France and Austria, Eugène persuaded the Duke of Savoy to join the Austrian Emperor, and in 1690 the prince and the imperial duke jointly commanded the forces in Piedmont. When the duke ended his allegiance, Eugène returned to Vienna and was raised to commander of the Hungarian army. He won a decisive victory over the Turks at Zenta (Sept. 11, 1697), a feat hailed throughout Europe. In the War of the Spanish Succession, he commanded the imperial troops in Italy. With Marlborough he defeated France and her allies at Hochstadt (Blenheim) in 1704. The following year he hastened to relieve Turin, and drove the French out of Italy, and in 1708 and 1709 again defeated them in the Rhine campaign. After concluding the Peace of Utrecht, 1714, Eugène again moved against the Turks, in 1717 capturing Belgrade. He died at Vienna, Apr. 21, 1736.

EUGENIA, a very numerous genus of aromatic trees and shrubs belonging to the myrtle family, several of which are cultivated in mild climates for ornament or for their edible fruits. Defined in a broad sense there are about 1,000 species; these are widely distributed in tropical regions; 8 species extend into southern Florida. They are evergreens, usually with scaly bark and hard durable wood, bearing opposite, mostly entire leaves, white or cream-colored, often show flowers in axillary clusters and drupe-like berries containing 1 to 4 seeds.

The dried flower-buds of the **CLOVE-TREE** (*E. aromatica*), native to the Moluccas, form the cloves of commerce. Among other widely known species are the pitanga or Surinam-cherry (*E. uniflora*), a large shrub native to Brazil, the rose-apple (*E. Jambos*), a small tree found in the East Indies, and the jambolan (*E. Jambolana*), a tree 50 to 80 ft. high, native to the East Indies and Burma, all more or less cultivated for ornament and for their edible fruits.

EUGENICS, a science and art defined by Francis Galton as "the study of all of the agencies under social control which may improve or impair the inborn qualities of future generations of men, either physically or mentally." A group of men who are interested in applying some of the results of the study of the agencies mentioned by Galton, known as educationalists or propagandists of eugenics, has arisen in consequence. But a clear fission is arising among the adherents of eugenics. One class is concerned in the

study of human heredity, genetics; the other class in bringing about the application of the results of genetical study to the improvement of mankind. The work of the latter group is sometimes spoken of in Europe as eugenics in the narrow sense.

Human genetics is the science of the origin and inheritance of germinal, or constitutional, differences. It rests on the foundation that human differences are not due merely to differences in the environment in which (assumed) similar fertilized eggs have developed, but, on the other hand, that fertilized eggs carry very different potentialities; that the universe of fertilized human eggs is the most variable population to be found in any stage in development; that later stages in development are accompanied by the elimination of non-viable, or disadvantageous, genetical combinations; that the universe of newly born children is already one highly selected in the direction of fitness to live and that the universe of children of 8 to 10 years is still more homogeneous, despite the fact that a decade of varying environment has already acted upon them. From this time on the effect of external conditions of development has a marked influence upon the final result, but the nature of the modification wrought by environment depends predominantly upon the genetical constitution of the developing person which reacts to that environment.

A body of data has been gained by studies on human genetics. Galton was one of the great early contributors; commonly called the founder. With the establishment of the Mendelian theory contributions have been made through the organization of the Eugenics Record Office, established by Mrs. E. H. Harriman, 1910 (in 1931 under the Carnegie Institution of Washington). A similar organization was started in 1927 at Dahlem-Berlin. The older organization especially has analyzed human genetical factors in many physical and physiological traits.

On the applied science of eugenics may be cited the attempts at improving a population by the control of immigration, by sterilization and by inducing or forcing the mentally defective or insane to avoid reproduction. On this side much progress is being made. On the educational side efforts are made to influence young people to make the best possible matings; to induce the better endowed classes to have relatively more children. Progress here will be slower. Legislation is being sought to diminish the burden of taxation on those producing families of effective children or even to increase the taxation upon well-endowed men who prefer, for convenience sake, to remain bachelors. The principal organizations devoted to applied eugenics are the Eugenics Society of England and the American Eugenics Society with its headquarters at New Haven. C. B. D.

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EUGÉNIE, MARIE DE MONTIJO (1826-1920), Empress of the French from 1853 until 1870, was born at Granada, Spain, May 5, 1826; her father was a Spanish grandee and her mother was the

daughter of a Scotch-born American citizen. From the age of eight she lived chiefly in Paris, where she was launched on a brilliant social career. In Jan. 1853, shortly after the proclamation of the Second Empire, NAPOLEON III announced his betrothal to her; the marriage took place at Notre Dame Jan. 30. Presiding with grace, over an elaborate court, the Empress showed herself wilful and imperious when she meddled in public affairs. She acted three times as regent. Her courage during the disastrous Franco-Prussian War won her the respect of her enemies. After the fall of the empire she lived in retirement in England, suffering the tragic loss of her only child, the prince-imperial, in the Zulu War, in 1879. Eugénie died while visiting her god-daughter, the Queen of Spain, in Madrid, July 11, 1920.

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EUGENIUS (Eugene), name of four popes. St. Eugenius I, 655-657, appointed by Emperor Constant II in place of Martin I, was not recognized by the clergy until the latter's death. He was canonized. Eugenius II, 824-827, a Roman, promulgated the Roman Constitution. He issued important instructions on Church discipline and the education of the clergy. Blessed Eugenius III, 1145-53, a former abbot and pupil of St. Bernard of Clairvaux, was driven from Rome three times. While in France, he created enthusiasm for the Second Crusade. Eugenius IV, 1431-47, though he promised to reform the Church at the Council of Basel, dissolved the council, but later recognized it. Differences caused him to be deposed. He opened another council in Florence, which led to nothing.

EUGENOL, a substance having a spicy odor and occurring in oil of cloves and in lesser quantities in many other volatile oils. Chemically, it is allyl guaicol, $C_{10}H_{12}O_2$, a colorless oil boiling at about $247^{\circ}C$. It may be synthetically prepared by the reduction of coniferyl alcohol.

EULACHON, a name of Indian origin given to a small, exceedingly oily fish of the smelt family found on the Pacific coast from Oregon northward. See CANDLEFISH.

EULENSPIEGEL, TILL, or The Owlglass, the knavish hero of a German legend; first High German version, 1519. He is the archetype of the charlatan, a perfect jack-of-all-trades, able and eager to try his hand in every kind of adventure, rejoicing in trickery for its own sake, always delighted when he can play a prank or cheat his employer.

EULER'S CONSTANT, EQUATION AND FORMULA. Among the most important expressions bearing Euler's name are the following:

(1) Euler's Constant, the limit of

$$1 + \frac{1}{2} + \frac{1}{3} + \dots + \frac{1}{n} - \log n,$$

as $n \rightarrow \infty$, the value being 0.5772156

(2) Euler's Equation $\frac{dx}{\sqrt{X}} = \frac{dy}{\sqrt{Y}}$, where X and Y

are quartic functions of x and y differing only in the variable.

(3) Euler's Formula, $e^{\pi i} = \cos x + i \sin x$, whence, if $x = \pi$, we have $e^{\pi i} = -1$, in which the logarithmic base e , $\pi = 3.14159 \dots$, $i = \sqrt{-1}$, and the negative unit are combined in one formula. See POLYHEDRON.

EUMENIDES, in Greek mythology, goddesses of vengeance, the same as the Erinyes and the Roman Furiae or Dirae. The Eumenides were three sisters, Alecto, MEGAERA and Tisiphone, and were the daughters of either GAEA or Nyx (see Nox). They lived in Tartarus. As the avengers of crime, they had power to punish on earth or to take their victims to the lower world for others to punish. In early mythology the Eumenides were called Semnai. They are depicted wearing short tunic and hunting boots, and sometimes carrying whips or burning torches. Snakes are wound in their hair.

EUONYMUS, a genus of trees and shrubs of the staff tree family, many of which are grown as ornamentals, especially the Old World SPINDLE TREE and several Chinese and Japanese species, both deciduous and evergreen. Certain American species are known as burning-bush. See also WAHOO.

EUPHEMISM, replacement of words or phrases felt to be obscene, disagreeable, or dangerous by terms of opposite connotation. The ultimate basis of euphemism, which is an important factor in the development of vocabulary, seems to have been the widespread belief in "the power of the name," still underlying such phrases as "speak of the Devil, and he's sure to appear"—i.e., the word and that which it connotes are the same; it is essentially linguistic tabu. The names of dread or maleficent deities, and of animals believed to possess special or uncanny power, are especially subject to euphemism, as when the Greek Erinyes (perhaps "the furious ones") were called Eumenides ("Kindly") or Semnai ("August") to propitiate them; or as when the bear ("brown one"), itself probably a replacement for "the harmful one" (seen in Latin *ursus*), is termed in SLAVIC "honey-eater" to avert its anger. The same feeling leads to avoidance of names of the Deity, etc., except in proper surroundings, and is responsible for "clipped oaths," as *zounds*=*God's wounds*, French *parbleu*=*par Dieu*.

Euphemisms tend to receive all the unpleasant connotations of the words which they replace, so that in time they must frequently be themselves replaced: or, with a change of standards, a euphemism may be discarded as unnecessary. L. H. G.

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EUPHORBIA, a very numerous genus of the spurge family comprising probably more than 1,000 species, very widely distributed throughout the world, about 100 of which occur in North America. They are mostly herbs but often shrubs, frequently cactus-

EUROPE

Ar. 3,787,143 sq. m.
Pop. 497,661,304

COUNTRIES

ALBANIA... P 13
Area 17,374 sq. m.
Pop. 1,003,077
ANDORRA... N 6
Area 191 sq. m.
Pop. 5,231
AUSTRIA... M 11
Area 32,360 sq. m.
Pop. 6,726,113
BELGIUM... J 8
Area 11,780 sq. m.
Pop. 8,129,405
BULGARIA... O 15
Area 39,814 sq. m.
Pop. 5,944,900
CZECHOSLOVAKIA... L 12
Area 54,192 sq. m.
Pop. 14,726,153
DANZIG... FREE CTRY. I 13
Area 754 sq. m.
Pop. 407,517
DENMARK... H 10
Area 16,604 sq. m.
Pop. 3,550,656
ESTONIA... G 14
Area 18,354 sq. m.
Pop. 1,117,000
FINLAND... E 14
Ar. 149,954 sq. m.
Pop. 3,634,040
FRANCE... L 7
Ar. 212,681 sq. m.
Pop. 41,834,923
GERMANY... J 11
Ar. 181,662 sq. m.
Pop. 64,600,000
GIBRALTAR... Q 3
Area 2 sq. m.
Pop. 21,372
GREAT BRITAIN... and N. IRELAND H 6
Area 94,278 sq. m.
Pop. 46,189,445
GREECE... Q 14
Area 54,092 sq. m.
Pop. 6,315,000
HUNGARY... N 13
Area 35,875 sq. m.
Pop. 8,683,740
ICELAND... B 5
Area 39,709 sq. m.
Pop. 108,600
IRISH FREE STATE... H 5
Area 26,592 sq. m.
Pop. 2,957,000
ITALY... O 10
Ar. 119,703 sq. m.
Pop. 41,145,041
LATVIA... H 14
Area 25,395 sq. m.
Pop. 1,900,050
LITHUANIA... I 14
Area 21,683 sq. m.
Pop. 2,392,983
LUXEMBOURG... K 8
Area 998 sq. m.
Pop. 300,748
MONACO... N 8
Area 8 sq. m.
Pop. 24,927
NETHERLANDS... J 9
Area 13,202 sq. m.
Pop. 7,832,175
NORWAY... B 10
Ar. 124,984 sq. m.
Pop. 2,809,564
POLAND... J 14
Ar. 149,915 sq. m.
Pop. 31,104,000
PORTUGAL... O 2
Area 34,787 sq. m.
Pop. 6,660,852
ROMANIA... M 15
Ar. 122,282 sq. m.
Pop. 18,176,757
SPAIN... O 4
Ar. 195,010 sq. m.
Pop. 22,760,854
SWEDEN... F 12
Ar. 173,105 sq. m.
Pop. 6,141,571
SWITZERLAND... M 9
Area 15,940 sq. m.
Pop. 4,082,511
TURKEY (in Eur.)... P 16
Area 9,254 sq. m.
Pop. 1,044,306
UNION OF SOCIALIST REPUBLICS (in Eur.)... G 19
Ar. 1,707,496 sq. m.
Pop. 122,114,545
YUGOSLAVIA... N 13
Area 96,134 sq. m.
Pop. 13,930,918



like in appearance, abounding in an acrid, often poisonous, milky juice, sometimes possessing medicinal properties. The small flowers are clustered within a cup-shaped, somewhat calyx-like involucre, the whole structure resembling a single flower. Many species are commonly cultivated for ornament, as the Poinsettia (*E. pulcherrima*), the scarlet plume (*E. fulgens*), the crown-of-thorns (*E. splendens*), the Mexican fire-plant (*E. heterophylla*), snow-on-the-mountain (*E. marginata*) and the flowering-spurge (*E. corollata*). Various cactus-like species are grown in warm climates for their oddity.

EUPHRATES, a large river in western Asia, rising in the center of Armenia in two streams, the Kara-Su and the Murad, which unite close to Keban Maadin. The united stream emerges from a gorge in the Anti-Taurus in swift rapids, comes within 100 mi. of the Mediterranean, and then turns towards Iraq and the Persian Gulf. Its course henceforth is slow, for its fall is less than 10 in. to the mile. It frequently breaks its banks and changes its course, forming braided channels and extensive swamps. At Kurna it is joined by the Tigris and the joint river, the Shatt-el-Arab, flows 90 mi. to the Persian Gulf after a course of about 1,700 mi. In flood time steamers reach Meskenah, 60 mi. from Aleppo; but later in the year the Euphrates is shallow and unnavigable. Flooding is caused in springtime with the melting of snow on the Taurus and Anti-Taurus ranges. In May and June the water is highest, when the current, which seldom exceeds 3 mi. an hour, rises to 5. The peculiarities of the Euphrates are emphasized by the fact that it has not a single town of any size on its banks in Iraq.

The silt from the Tigris and Euphrates has formed a delta six times as large as that of the Nile. Gradually this deposit is extending into the Persian Gulf, so that the sites of ancient cities formerly on its coast are now miles inland. During the 5,000 years of which there is historic record, the sea has receded 150 mi. The land between the lower reaches of these rivers was one of the cradles of civilization.

EUPHROSINE, in mythology, one of the three GRACES, known in Greece as CHARITIES and in Rome as Gratiae. Euphrosyne was the goddess of mirth or joy.

EUPHUES "The Anatomy of Wit," an elaborate treatise on manners and morals in the form of a romance, by JOHN LYLY; published 1579. Sententious and abstract, having but slight human interest, this is the story of the courtly Euphues who, arriving in Naples (standing for London), falls in love with Lucilla, the fickle mistress of his friend Philautus, wins her but quickly loses her to another, and finally retires, disheartened, to his native Athens (Oxford) to study and to correspond voluminously with his friends. Its alliterative and highly ornamental style, which was partly imitated from *The Dial for Princes* by Don Antonio de Guevara, has made the book a landmark in English literature. The work was followed by a sequel, *Euphues and His England*, 1580.

EUPHUISM, a highly ornamented, affected style of speaking and writing, made fashionable in England, especially among ladies, after the publication of John Lyly's *EUPHUES*, 1579. The ardent euphuists used language of the utmost "refinement," balanced phrases in long chains of alliterative antitheses, and sprinkled their utterances or their prose with allusions drawn either from classic mythology or from the fabulous sciences of the day. The style was practiced by Greene, Lodge, Breton and others, and variations on the style by Shakespeare in *LOVE'S LABOUR'S LOST*. See also *ENGLISH LITERATURE*.

EUREKA, a port city on Humboldt Bay in northwestern California, the county seat of Humboldt Co., situated 2 mi. from the Pacific Ocean and 294 mi. northwest of San Francisco. Steamships, bus lines and the Northwestern Pacific Railroad serve the city; there is also an airport. Eureka is on the Redwood Highway, which passes through the heart of the redwood timber belt. Almost surrounded by magnificent forests of redwoods it has important lumber and shipping interests. The products handled in the harbor in 1929 amounted to 619,852 tons, worth \$19,750,153. In 1929 the industrial output was worth about \$5,000,000, and the retail business of 350 stores amounted to \$13,665,680. Poultry, stock-raising and farming are carried on in the vicinity. Near by at Arcata is Humboldt State Teachers College. Gen. Ulysses S. Grant was at one time in command of Fort Humboldt. Eureka was founded in 1850 and incorporated in 1856. Pop. 1920, 12,923; 1930, 15,752.

EUREKA SPRINGS, a city and the county seat of Carroll Co. in northwestern Arkansas, situated 265 mi. southeast of Kansas City. Railroads and bus and truck lines serve the city. Fruit, truck-garden and dairy produce are raised in the vicinity. Lumber manufacture is the chief industry. The city is built in the heart of the Ozark Mountains, and, on account of its therapeutic springs, is an attractive health resort. The city was settled in 1879. Pop. 1920, 2,429; 1930, 2,276.

EURIPIDES (c. 480-c. 406), youngest of the three great writers of tragedies who made Athens famous as the birthplace of the Drama. He was born in Salamis, about 480 B.C., according to tradition on the day of the great Greek victory against the Persians. His father was wealthy and the poet was famous for his rich collection of books. He was a student of philosophy, a pupil of Anaxagoras and Socrates, and a leader of the scientific modernism which, at Athens, followed the period of the Persian Wars. For his subversive views he was repeatedly attacked by ARISTOPHANES. Yet in poetical style Euripides was more conservative than Sophocles. He wrote more than 90 dramas, and was a constant competitor for honors in the theater at Athens, winning first prize five times. His plays are studies of character; they are even more expressions of passionate emotion called forth by unendurable situations. Eighteen plays have survived. *Hippolytus* is the earliest study of romantic passion. *Andromache* is a

woman's tragedy. The *Descendants of Hercules* shows the beautiful girl, Macaria, offering her life in sacrifice. The *Suppliants* is concerned with contemporary politics. In *Hecuba*, which depicts the sad mother of conquered Troy, there is once more the noble girl who gives her life in sacrifice, and a terrible picture of the despairing fury of Hecuba. *Alcestis* is a loyal wife, ready to die for her husband. Her gentle character is in sharp contrast to that of *Medea*, the furious, revengeful sorceress who murders her own children to inflict suffering on her husband, Jason. Other plays are similar studies of passionate feeling. They include the *Phoenician Women*, *Iphigenia in Tauris*, *Ion*, the *Bacchanals*, *Iphigenia in Aulis*, *Hercules Infatuated*, the *Trojan Women*, *Electra*, *Helen*, *Orestes* and a comedy, *Cyclops*. He died, probably at the Macedonian court, about 406 B.C.

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EUROPA, in classical mythology, daughter of Agenor or of Phoenix, King of Phoenicia, and sister of CADMUS. She was loved by ZEUS who carried her



EUROPA ON THE BULL
From a Greek amphora

off to Crete. Here she bore him MINOS, Rhadamanthus and Sarpedon. Zeus afterward gave her to King Asterius of Crete. She is the personification of Europe.

EUROPE, a continent of the eastern hemisphere, situated entirely north of the torrid zone with its northern boundary within the Arctic circle. Excepting Australia, it is the smallest and most densely populated continent on the globe. Its 3,700,000 sq. mi. of area lie within 71° 15' and 36° 23' N. lat. between North Cape, Norway, and Cape Matapan, Greece, and 65° E. and 10° 30' W. long. between the Ural Mountains and Dunmorehead, Ireland. The boundaries are the Arctic Ocean on the north, Atlantic on the east, Mediterranean and Black seas and Caucasus Mountains on the south, and the Ural Mountains and Caspian Sea on the east. Within the main water boundaries there are numerous marginal sea and gulfs which cut into the mainland, giving it a complex and irregular outline. The White Sea penetrates the Arctic coast; the North Sea, Skager-

rack, Cattegat, Baltic Sea and Gulf of Bothnia separate the Scandinavian Peninsula from the mainland; the English Channel and Strait of Dover lie between the British Islands and France; the Bay of Biscay protrudes between France and Spain; and along the Mediterranean coast the Adriatic and Ægean seas penetrate far into the continent. In all the coastline measures about 48,000 mi.

Besides the British Isles, the continent embraces Iceland and the Faroe Islands to the northwest, Nova Zembla off the north coast of Russia, and the Balearic Islands, Corsica, Sardinia, Sicily and Crete in the Mediterranean.

Surface Features. The European landscape is a complexity of blocks of highland and lowland which have no orderly arrangement. It can be divided roughly into three general physiographic provinces, the northern highlands and associated lowlands, the Great Central Plain, and the Southern Complex which is divided into the Alpine system of distinct linear ranges and a series of rounded highlands, or massifs, which are the roots of worn-down mountains. These two divisions overlap and are distinguished by the difference in their ages. The continent has a mean altitude of 980 ft., and a maximum elevation of 18,465 ft. on Mt. Elbruz in the Caucasus. The lowest position is the Caspian Sea which is 86 ft. below sea level.

The northern highlands include most of Scandinavia, the northern and western parts of the British Isles and northwestern France. These are all rugged lands of such meager resources that their peoples depend chiefly upon the sea for a livelihood. Scotland is divided into the northern or Scottish highlands, having an elevation varying from 1,000 to 2,000 ft., and the southern uplands; between them is a wide low trench with the Firth of Forth on the east and Firth of Clyde on the west. From the southern upland the Pennine Range, a rounded plateau some 160 mi. long, extends southward into England, imposing a barrier to communication between the Northumberland and Yorkshire coal fields on the east, and the Lancashire coal fields on the west. In Wales the highlands are an oblong mass of mountainous country approximately 3,000 ft. in elevation, the southern part of which constitutes the great Welsh coal fields. The Cornwall Peninsula of southwestern England and Brittany across the channel in France are both scraggy uplands. The former contains valuable tin, copper and kaolin deposits, and the latter is a dairying country. Ireland, like Scotland, has a northern and southern highland district and a lowland.

The Scandinavian Peninsula constitutes the largest uninterrupted mountain region in Europe. Along its west side, in Norway, are the Kiølen Mountains reaching from Stavenger to North Cape. They are from 4,000 to 5,000 ft. high and on the west descend sharply to the ragged fiords of the Atlantic coast. On the east they drop 2,000 ft. to the heavily forested Swedish highland belt known as the Woodland. The eastern coast of Sweden is a lowland simi-

lar to southern Finland. One-third of the surface of the latter country is occupied by small lakes.

The Great Central Plain is a continuous belt extending from France eastward along the North and Baltic seas into Russia where it expands to form the entire width of the continent. Its only interruptions are the narrow channels separating the plains of southern England and Sweden from the continental lowlands. Throughout this belt the formations are flat and the landscape subdued but there is sufficient diversification to establish several minor divisions. At the north, in Russia, the tundra region lies next to the Arctic between the White Sea and northern Urals. Immediately south of it is the central Russian tableland, a combined forest and agricultural district, and across southern Russia runs the black earth belt or steppeland, east of which are the sandy salt steppes bordering the Caspian Sea.

In France the most distinctive area is the Paris Basin, the structure of which may be compared to pyramided saucers the upturned edges of which form *cuestas*, or plains, sloping outward. Paris is situated at the center. The lowlands of southern England and those of Belgium, Holland, Denmark, northern Germany, Poland and the Baltic states occupy dissected coastal plains.

The older highlands of the Southern Complex occur in Spain, France, Germany and Bohemia. Had they preserved their original continuity they would create a continuous barrier between north and south Europe, but the worn-out sections now provide numerous gateways for transverse communication. The Spanish Meseta is the stump of an old mountain area reaching from the Bay of Biscay on the north to the Andalusian lowland on the south, and bounded on the west and east by the Portuguese and Valencia lowlands. The Aragon plains lie to the northeast. In south central France there is a roughly circular massive surrounded by distinctly lower regions. The eastern section is composed of the Cevennes Mountains which overlook the Rhône Valley, the central part contains the Limousin region. In northeastern France the Vosges Mountains look down to the east on the Rhine Graben, across which, in Germany, is the Black Forest. In western Germany the Rhenish Slate Mountains are cut almost in two by the deep Rhine River gorge and its tributaries. In central Germany there is a region of basins and broken ranges composed of the Hessian Highlands in the west, and the Harz Mountains and Thuringian basin and forest in the east. Between Germany and Czechoslovakia there is a circular highland formation surrounding the Bohemian basin.

The Alps which curve from the Mediterranean northward between France and Italy and eastward through Switzerland and Austria, constitute the central range of the Alpine system, a series of only slightly broken mountain chains. Their highest peak is MONT BLANC, 15,781 ft. At their western terminal they swing sharply southward into the Apennines which have a maximum elevation of 9,560 ft. They

include also two separate chains in Spain; the Sierra Nevadas along the southern coast and the Pyrenees which rise to 11,168 ft. At Vienna, the eastern terminal of the Alps, the system divides into two branches, the Carpathian, which are curves southward to form the Transylvania Alps, and the Balkan range and the Dinaric Alps which follow the coast of the Adriatic and continue in Greece as the Pindus Range. Associated with these highlands are the lowlands of the Po Valley in Italy and the Hungarian and Rumanian plains.

The Ural Mountains along the eastern border are remnants of an old mountain chain now reduced to about 5,000 ft. The Caucasus Mountains on the southern boundary are higher than any of the interior. Besides MT. ELBRUZ they contain 12 peaks of over 16,000 ft.

The mountainous areas give rise to numerous rivers most of which have but a short distance to go before reaching the sea. The longest streams occur in Russia where there is a far-reaching mass of land. The Volga which discharges into the Caspian Sea is 2,300 mi. long; the Don and Dnieper, both tributaries of the Black Sea, are 1,300 and 1,400 mi. long respectively. The Dvina which flows to the Arctic Ocean is 1,000 mi. long. Of the rivers of western Europe, the Danube has a course of 1,750 mi. eastward before emptying into the Black Sea; the Rhone, 500 mi. long, empties into the Mediterranean; and the Rhine, 800 mi., and Elbe, 700 mi. long, empty into the North Sea.

The largest lakes of the continent are Ladoga, 7,000 sq. mi., and Onega, 3,764 sq. mi., both situated in Russia. Those of western Europe are noted for their beauty rather than size. They include Como, Garda, Maggiore, Lucerne, Constance and Geneva, all of which are situated near or in the Alps. Lake Vener in Sweden has an area of 2,400 sq. mi., the third largest lake of Europe; Lake Vetter in southern Sweden is noted for the transparency of its waters. The lakes of Scotland and England, known for their historic and literary associations rather than for their size, include Windermere and Lochs Lomond, Katrine, Tay, Ness, Morar and others.

For a discussion of the geology and more extended details regarding the physiography of the continent see E. Suess, *The Face of the Earth*, 1904-24; G. A. J. Cole, *The Growth of Europe*, 1908; J. Geikie, *Structural and Field Geology*, 1920; A. Wegener, *The Origin of Continents and Oceans*, 1924; J. Joly, *The Surface History of the Earth*, 1925; P. Lake and R. H. Rastall, *Textbook of Geology*, 1927.

Climate. With the exception of a relatively small area lying north of the arctic circle, Europe is situated wholly within the temperate zone, with its major portion in the more northerly latitudes. It is the only continent that does not extend within the tropics, and, save Australia, the mean elevation of its surface above sea-level is lower than that of any other continent. The various peninsulas and the deep indentations in its coasts bring many parts of Europe close to the sea, which has a moderating effect upon the climate. More important still, the climate

of northwestern Europe, like that of the western coast of North America, is profoundly influenced by the northeasterly drift of warm oceanic waters from subtropical regions and by the prevalence of mild, moist, southwesterly winds. The ameliorating effects of the Gulf Stream drift in the North Atlantic are felt not only on the western shores of Europe but also on portions of the arctic coast. As far east as the Murman coast of Lapland harbors remain open all winter. At Edinburgh, Scotland, are grown in the open ornamental plants that winter kills at New York City, about 1100 mi. farther south.

Large portions of northern Europe lie within the path of the moist westerly winds that bring sufficient rain for the support of an intensive agriculture yielding food for dense populations. Unlike other continents, Europe has no entirely desert areas. The generally equable and salubrious climate of the continent, which is not surpassed by that of any other equal area on the globe, has been a factor of inestimable importance in the development of western civilization.

The climatic provinces are the arctic, the marine or oceanic, the continental and the Mediterranean. The small arctic province occupies the lowland tundra region lying across and above the arctic circle where the summer temperature fails to rise to 50° F. for as much as three months in the year. The marine or oceanic province comprises the entire area west of Russia and north of the Alps and associated ranges. Although there is a distance of about 20° between its northern and southern boundaries, there is but slight difference in the temperatures. The average readings for January and July are, in Stockholm, 27° and 62°; in Vienna, 29° and 67°; in London, 39° and 63°; in Paris, 37° and 66°, and in Berlin, 31° and 65°.

Russia, which is chiefly lowland and some distance removed from any large body of water except the Arctic Ocean, has the continental climate. In this province the averages for the coldest and hottest months are, in Leningrad, 15° and 64°; in Moscow, 12° and 66°, and in Odessa, 25° and 73°.

The subtropical climate along the Mediterranean is characterized by mild rainy winters and hot dry summers which are somewhat moderated by winds from the sea. The mean temperatures for January and July are in Madrid, 40° and 76°; in Rome, 44° and 77°; in Athens, 48° and 81°, and in Istanbul, 41° and 74°.

Flora. Largely because of the northerly position and relatively small area of the continent, Europe on the whole is covered by vegetation of a generally uniform character. There are three fairly distinct floral divisions, the plants of which more or less overlap or intermingle. These divisions are the central region comprising most of the lowlands lying north of the Alps and Pyrenees, the Arctic region lying at the extreme north and the Mediterranean region extending from the Atlantic south of the Pyrenees, Alps and Carpathians eastward to Asia Minor.

Of the great central region, which includes most of the continent, the flora of Germany containing about 2,500 species of flowering plants and ferns is typical. This vegetation consists of forest trees, shrubs and perennial plants in many respects similar to those found in the eastern United States and adjacent Canada, including species of pine, fir, spruce, larch, poplar, willow, birch, alder, beech, oak, elm and maple. Large areas in central Europe were once covered with dense forests of conifers at the north, such as now exist in Scandinavia, and of mixed evergreen and deciduous trees at the south. In the northern part of the central region there are extensive tracts of heath or moor, largely covered with heather, broom and bracken. In eastern and southeastern Europe, as in Russia and the Danube Valley, there are large treeless prairie-like districts similar to the grassy steppes of Asia.

North of the limit of forests and of cultivation are the Russian tundras, occupying a relatively small area in the northeast. These possess a true Arctic flora, consisting chiefly of mosses intermingled with dwarf shrubs and perennial herbs bearing conspicuous brilliantly colored flowers, as primroses, poppies, saxifrages and buttercups. *See also* TUNDRA.

The Mediterranean region, comprising the richest and most varied flora of the continent, is estimated to contain about four-fifths of all the species found in Europe. In ancient times forests were spread over large areas, but the existing forms are mostly low trees, with leathery drouth-resistant foliage, as the evergreen oak, holly, carob, laurel, myrtle and olive. These often occur in scattered clumps or thickets or *macchie*, a formation somewhat resembling the CHAPARRAL of the southwestern United States. Numerous fleshy plants, including the cactus, agave and aloe introduced from other regions, form a characteristic part of the vegetation. Europe has furnished many valuable economic plants as oats, rye, timothy grass, various clovers, cabbage, lettuce, field pea, turnip, carrot, and parsley.

Fauna. The animals of Europe differ but slightly from those found in Asia north of the Himalayas, the two areas forming the Palearctic zoological region. Because of the density of the population, the extensive removal of the original forests, and the age-long cultivation of large areas, many native animals formerly abundant have become extinct or are found only in very limited districts. Among the larger or more interesting of the mammals still existing are the polar bear, and Arctic fox widespread in the extreme north, the brown bear found mostly in Scandinavia and Russia, the European bison of Lithuanian forests, the elk in the Baltic region, the reindeer in Lapland, the red deer or stag in Scandinavia, the fallow deer and roe deer of southern Europe, the wolf still common in Russia and Poland, the lynx in Norway and Sweden, the chamois widespread in the southern mountains, the musimon in Corsica and Sardinia, the ibex in Crete, and the beaver in eastern Europe. A species of macaque

known as the Barbary ape, the only monkey found in Europe, inhabits the Rock of Gibraltar.

The birds of Europe are numerous and varied; many are migratory. Representative groups are many thrushes, as the robin redbreast and the nightingale; numerous sylvian warblers, and various finches, sparrows, linnets, crossbills, and kingfishers, starlings, magpies, goatsuckers and wood pigeons. The game birds include various species of plover, snipe, woodcock, curlew, partridge, quail, grouse, ptarmigan, duck, geese and bustard. Among the birds of prey are eagles, falcons, vultures, owls and ravens. Other large birds are cranes, herons, ibises, storks and flamingoes.

Reptiles are scantily represented, and only one native north European snake, the common viper, is venomous. Several amphibians, as the blind proteus and the obstetrical toad, are peculiar to Europe. Frogs, toads, tree toads and salamanders are abundant. Representative fresh-water fishes are perch, pike, carp, trout, gudgeon, chub, tench, and bream. Among the marine fishes are several of great economic value, as herring, cod, mackerel, and sole.

Political Divisions. With the exception of Russia, which comprises nearly half the continent, the political units are small. The different countries with areas and approximate population are:

Divisions of the British Empire: England, 50,874 sq. mi., 37,903,687, 1931; Wales, 7,466 sq. mi., 2,158,193, 1931; Scotland, 30,405 sq. mi., 4,842,554, 1931; Northern Ireland, 5,263 sq. mi., 1,256,561, 1926; Irish Free State, 26,585 sq. mi., 2,971,992, 1926.

Kingdoms: Albania, 10,629 sq. mi., 1,003,068, 1930; Belgium, 11,755 sq. mi., 8,129,824, 1930; Bulgaria, 39,814 sq. mi., 5,483,125, 1926; Denmark, 16,568 sq. mi., 3,542,230, 1930; Hungary, 35,875 sq. mi., 8,742,000, 1930; Iceland, 39,709 sq. mi., 106,000, est. 1929; Italy, 119,710 sq. mi., 41,173,000, 1928; Netherlands, 13,210 sq. mi., 7,938,114, 1931; Norway, 125,086 sq. mi., 2,809,564, 1930; Rumania, 122,282 sq. mi., 18,326,000, est. 1930; Sweden, 173,146 sq. mi., 6,310,902, 1931; Yugoslavia, 96,134 sq. mi., 13,930,918, 1931.

Republics: Austria, 32,369 sq. mi., 6,534,481, 1923; Czechoslovakia, 54,207 sq. mi., 14,726,158, 1930; Estonia, 18,353 sq. mi., 1,117,000, est. 1931; Finland, 132,589 sq. mi., 3,634,047, 1929; France, 212,659 sq. mi., 41,834,923, 1931; Germany, 181,723 sq. mi., 62,410,619, 1925; Greece, 49,912 sq. mi., 6,394,000, est. 1930; Latvia, 25,000 sq. mi., 1,895,016, 1929; Lithuania (Independent) 20,426 sq. mi., 2,367,000, 1931; Poland, 149,958 sq. mi., 31,757,448, 1931; Portugal, 35,490 sq. mi., 6,660,852, 1931; Spain, 196,607 sq. mi., 22,760,854, est. 1929.

Miscellaneous: Russia, belonging to the Union of Soviet Socialist Republics, 1,570,000 sq. mi., 100,000,000, est. 1931; the Confederacy of Switzerland, 15,940 sq. mi., 4,054,400, est. 1930; the Grand Duchy of Luxemburg, 999 sq. mi., 300,748, 1930; the Free City of Danzig, 754 sq. mi., 407,517, 1929; and the Principality of Monaco, 8 sq. mi., 24,927, 1928.

The total number of people is estimated at 463,000,000.

The three chief races of Europe are the Teutonic or Nordic, occupying the northern lands, characterized by blond complexion, flaxen hair and oval heads; the Alpine, called also Celtic, which must be distinguished from peoples speaking Celtic languages, have broad faces, round heads and complexion intermediate between the light Teutonic type and the Mediterranean race; and lastly, the Mediterranean. The last named, which inhabits the Mediterranean countries, are dark and long headed. Both the Alpine and the Mediterranean types are shorter in stature than the Teutonic. In the competition for territorial area and in numerical increase the Alpine stock has been the most successful. The Teutonic stock has but slightly extended its boundaries, while the Mediterranean has failed to hold important lands formerly occupied. But the minor races, the Teutonic and the Mediterranean, have initiated the foremost evolutionary movements of modern times, as, for example, those started by Mediterranean peoples of Spain in the 15th century and by the Nordic peoples of England shortly thereafter.

In Europe the Mongolian race is represented by the Magyars in Hungary and the Tatar element in the Russian and Finnish population.

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EUROPIUM, a metallic chemical element (symbol is Eu, atomic weight 152.0°), belonging to the rare earths, exceedingly scarce in nature, and detected by Demarcay in 1896. Solutions of its salts have a pale rose color.

EURYANTHE, an opera in three acts by C. M. von WEBER, libretto by Helmine von Chezy; première, Vienna, 1823, New York, 1863. It is the second of von Weber's three well-known operas, succeeding the more successful *Der Freischütz*. It is infrequently produced.

Count Adolar is betrothed to Euryanthe. He meets the sneers of Count Lysiart who boasts that he can win her. The two nobles wager their possessions. In the palace of Nevers, Eglantine falls in love with Adolar, at the same time winning her way into the confidence of Euryanthe who, in a moment of weakness, reveals a secret regarding Adolar's sister, who committed suicide by drinking poison from a ring which must be wet with the tears of an innocent person accused of a crime before her soul will find escape from its sorrows. Euryanthe had been sworn to secrecy by Adolar. Eglantine immediately goes to the tomb of Adolar's sister, takes the ring from the corpse's finger, and gives it to Lysiart who now proclaims that Euryanthe had told him the secret. Lysiart maintains that he has won the wager, and Adolar drags Euryanthe to the forest where he in-

tends to kill her and to commit suicide. A serpent interferes with his plans, and Adolar leaves Euryanthe in the forest. Presently, however, upon their joint return, the king intervenes, telling Adolar that Euryanthe is dead, hoping thus to punish him for his false suspicions. Although Eglantine is about to be married to Lysiart, the news of Euryanthe's death fills her with triumph, for she still loves Adolar. Gloating over the death of her rival, she reveals the entire plot in which Lysiart was implicated, and for this she is killed by her prospective husband. At the same moment Euryanthe rushes into the arms of her adored Adolar whose dead sister now finds eternal repose, since her ring has been wet with the tears of the innocent Euryanthe.

EURYDICE, in Greek mythology, a nymph, wife of ORPHEUS. She died from the bite of a serpent as she fled from the pursuit of Aristaeus. Orpheus descended to Hades to beg Pluto to restore her to him. Pluto, charmed by the music of Orpheus's lyre, granted his request, on the condition that he should not look back on his way from Hades. When almost out he turned to see if Eurydice were following, and immediately she was snatched from his sight.

EUSEBIUS OF CAESAREA (c. 264-c. 341), bishop of Caesarea and "the Father of Church history," was born probably at Caesarea, about 264. He suffered a short imprisonment in the Diocletian persecution, and saw many martyrdoms, although he remained unharmed. Throughout his life as a theologian and historian, he appears to have been a favorite with the Emperor Constantine. He was made bishop of Caesarea in 315, and 10 years later attended the Council of Nicea, where he was appointed to receive the Emperor, in whose presence he gave a panegyric oration. At the council he took a leading part in framing the NICENE CREED, but is chiefly honored for his *Ecclesiastical History*. He died at Caesarea before 341.

EUSTACE, ROBERT. See WACE, ROBERT.

EUSTACHIAN TUBE, or auditory tube, a passage connecting the middle ear with the nasal part of the pharynx. It lies along the lower surface of the skull and is composed chiefly of cartilage, but partly of bone, and lined with epithelium.

It communicates with the outer air and its function is to equalize the air-pressure inside the middle ear with that of the surrounding atmosphere, in order that the delicate ear drum may not be ruptured or the hearing impeded by differences in pressure. The act of swallowing opens the passage to access of external air.

If the Eustachian tube becomes closed by mucus or by the swelling consequent to inflammation, ringing in the ears or a sense of fulness of the ears is likely to be noticed. There is also what is known as throat deafness, relieved when the inflammation is overcome. (See also HAY FEVER.) Infection can readily pass from the pharynx into the middle ear through the auditory tube.

EUSTACHIO, BARTOLOMMEO (?-1574), Italian anatomist. Neither the date nor place of his birth is known. In 1562 he was professor of medicine at Rome and the leading anatomist of the city. For some years preceding his death he had been physician to the Pope. Eustachio greatly advanced the knowledge of anatomy, discovering the Eustachian tube between the mouth and ear, and the Eustachian valve of the heart. His other discoveries included the stapes, one of the important small bones of the inner ear, the method of tooth growth, and the structure of the kidneys. Many of his discoveries appeared in the *Opuscula Anatomica*, Venice, 1563. He died at Rome in August, 1574.

EUTAW SPRINGS, BATTLE OF, Sept. 8, 1781, the final battle of Gen. Greene's campaign, in the REVOLUTIONARY WAR, to oust the British army from the Carolinas. The engagement, 60 miles northwest of Charleston, involved 2,000 Continental troops and a British force of 2,500 under Generals Stuart and Rawdon. In the first charge, at dawn, Greene's army was victorious, but failed to pursue its advantage while the British rallied and thereafter ably defended their position. The British loss was about 800 men, the American's about 600. At night the British withdrew toward Charleston; Greene followed, but did not offer battle. The British had been driven out of the Carolinas, with the exception of Charleston, which they held until Dec. 1782.

EUTECTIC MIXTURE, an apparently homogeneous, but actually heterogeneous, mixture of solids obtained as the result of final solidification on cooling of a liquid containing two or more substances. The apparent homogeneity results from the fact that in the formation of the eutectic two or more solids separate simultaneously from the liquid in the form of exceedingly small crystals; the actual heterogeneity can be demonstrated under sufficiently powerful magnification. The word "eutectic" means, by derivation, "lowest melting"; the eutectic mixture is in fact that mixture which has the lowest melting point of any mixture of the two substances composing it. While not all mixtures form eutectics, they are nevertheless of very common occurrence; they are met with in the case of solutions of salts in water, in mixtures of salts and in metallic alloys. Thus common salt and water form a eutectic mixture containing about 24% of salt and freezing at -23° C. The metals lead and antimony form a eutectic containing 87% of lead and melting at 246° C. A most useful property of the eutectic is that when in contact with its melt it will maintain a constant eutectic temperature. There is thus made available a ready means of producing constant temperatures either above or below room temperature depending upon the system selected.

L. O. C.

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EUTERPE, in mythology, one of the nine MUSES. **EUTROPIUS** (died about 370 A.D.), Roman historian. An officer in the imperial court at Constanti-

nople, he wrote in Latin a history of Rome from its foundation to the accession of Valens, 364, entitled *Breviarium Historiae Romanae*. It was used as a text-book in antiquity. A continuation to the time of Justinian was appended by Paulus Diaconus.

EUTYCHIANUS, ST. (3rd century), a Roman pontiff of whose history practically nothing remains. He was pope from 275 to 283, succeeding Felix I, and a Roman church calendar of the 4th century gives Dec. 8 as the day of his feast.

EUXINE SEA. See BLACK SEA.

EVANGELINE, the heroine of a narrative poem of that name by HENRY WADSWORTH LONGFELLOW, published in 1847. The daughter of Benedict Bellefontaine, a rich farmer of Acadia, modern Nova Scotia, Evangeline is betrothed when 17 to Gabriel, son of a blacksmith. But the colony is exiled by order of George II and Evangeline and Gabriel are parted. After long, fruitless wanderings in search of Gabriel, the heroine settles at last in Pennsylvania, where, grown old and hopeless, she becomes a Sister of Mercy. While visiting an almshouse during a plague, she sees an old man who dies as he utters her name. Evangeline and Gabriel are buried side by side.

EVANS, MARY ANN. See ELIOT, GEORGE.

EVANSTON, a residential suburb of Cook Co., Ill., adjoining Chicago on the south, with frontage on Lake Michigan. It is served by two main railroads. The city is the seat of NORTHWESTERN UNIVERSITY, founded in 1851, which has an extensive campus. Among other institutions located here are Garrett Biblical Institute, Western Theological Institute, and the National Kindergarten and Elementary College. In 1929 the factory output was about \$11,000,000; retail trade amounted to \$46,914,483. Evanston has been the home of FRANCES E. WILLARD, the well-known reformer, and of W. H. Barnes, organ architect and recitalist (b. 1892). The town developed around the university and was incorporated in 1872; it became a city in 1892. Pop. 1920, 37,234; 1930, 63,338.

EVANSTON, a town in southwestern Wyoming, the county seat of Uinta Co. It is situated on the Bear River, 75 mi. northeast of Salt Lake City, Utah, and is served by the Union Pacific Railroad. The town lies in a coal and oil producing region, surrounded by stock-ranches and dairy farms. The chief local industry is railroad shop work. Evanston is the seat of the State Hospital for the Insane. Pop. 1920, 3,479; 1930, 3,507.

EVANSVILLE, a city in southeastern Indiana, the county seat of Vanderburg Co. It is an inland port on the Ohio River, about 100 mi. southwest of Louisville, Ky. Bus and truck lines, airplanes, river craft and several railroads make Evansville an important transportation center. Farming and coal-mining are important interests of the vicinity. Two mines are within the city's limits. Evansville is an important lumber shipping point and has various manufactures; chiefly furniture, store fixtures, and other lumber products, stoves, furnaces, autos, trucks and electric refrigerators. The factory output for 1929 was worth about

\$95,000,000. The retail trade in 1929 amounted to \$47,426,393, and the wholesale trade proper, to \$34,113,029. Evansville was chartered as a city in 1847. Evansville College and a state insane asylum are here. Pop. 1920, 85,264; 1930, 102,249.

EVAPORATION, in a steam BOILER, the process by which water is converted into steam. Its rate depends upon the temperature of the feed water, the pressure under which the steam is generated and the temperature to which it is superheated. In order to compare the capacities of boilers operating under different conditions, an equivalent evaporation is therefore calculated "from and at 212° F.," i.e., from feed water at 212° F. converted into saturated steam at the same temperature. This calculation consists of multiplying the actual evaporation by a factor of evaporation which is equal to the heat required to generate 1 pound of actual steam divided by 970.2 British Thermal Units of the heat required to generate 1 pound of steam from and at 212° F.

W. L. DE B.; K. T.

EVAPORATION AND EVAPORATORS. In the chemical industries an evaporator is always a device for boiling solutions. The apparatus in which "evaporated" fruits and vegetables are made is always called a drier. Solutions are rarely evaporated by direct fire. The most common case of boiling with direct fire is the steam boiler. Most solutions that must be concentrated, are concentrated in steam-heated evaporators. These fall into two general types, the horizontal-tube and the vertical-tube types.

In the horizontal-tube type the liquid is placed in a vessel through which run a number of horizontal tubes. The steam that furnishes the heat is inside these tubes. In the vertical-tube type the vessel is in the form of a vertical cylinder. Two horizontal plates extend across it, and between these plates are fastened a number of tubes open at both ends. The steam that furnishes the heat is in the space between the plates and outside the tubes. The liquid to be boiled is inside the tubes. A passage is provided to return the liquid that spouts out of the tubes back to the space below the tubes. Such evaporators may be from 3 ft. to 20 ft. in diameter, and from 6 ft. to 60 ft. high. A large evaporator may evaporate over a million pounds of water a day.

Evaporators are frequently, but not necessarily, operated with the space containing the liquid maintained under a vacuum. Multiple-effect evaporation, a method extremely important from the standpoint of steam economy, is a method of operation in which a series of evaporators are maintained at different pressures so that the vapor boiled off from the solution in one vessel may be used as the heating medium in the next, which boils at a lower pressure, and hence a lower temperature. The result of this arrangement is that one pound of steam may be made to evaporate as much as three or four pounds of water.

Evaporators are used in the manufacture of sugar (beet and cane), salt, many miscellaneous chemicals,

glue and gelatine, glycerine, in the recovery of waste liquors from the manufacture of paper pulp, and for concentrating fruit juices and milk. W. L. B.

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EVARISTUS (?-c. 105), was the fourth pope, the successor of Clement. He was elected pope about 98 A.D. and died about 105. He was buried near the tomb of St. Peter in the Vatican.

EVARTS, WILLIAM MAXWELL (1818-1901), American lawyer and statesman was born at Boston, Mass., Feb. 16, 1818. He prepared for college at the Boston Latin School and graduated from Yale 1837. He attended the Dane Law School of Harvard College and later studied for two years in a New York City law office, being admitted to the bar in 1841. He rapidly achieved a reputation as a brilliant lawyer. He was assistant U.S. attorney for the southern district of New York, 1849-53.

Originally a Whig, Evarts' disapproval of slavery led him into the ranks of the Republican party where his legal skill was used in cases of a semi-public nature such as his representation of New York state in the Lemmon Slave Case, 1860. In 1868, he was chief counsel for Andrew Johnson in the impeachment proceedings. From July 15, 1868 to Mar. 1869 he was attorney-general of the United States. His talented handling of many famous cases of various natures led to his selection as counsel for the U.S. in the Alabama claims arbitration at Geneva.

Evarts was chief counsel for the Republican party in the Hayes-Tilden presidential election dispute and was Secretary of State in Hayes' cabinet, 1877-81. His appointment was opposed by some Republican leaders who had been previously annoyed by his unswerving disapproval of the use of public office as reward for partisan activity. He was U.S. Senator, 1885-91. During his years in the Senate he developed eye trouble which culminated in total blindness. Evarts died in New York City, Feb. 28, 1901.

EVE, according to the account of the origin of the world given in the Book of Genesis, the wife of the first man and the mother of all mankind. The name in the Hebrew original text is Hawwah, which many scholars believe to have been originally an abstract rather than a proper name. It suggests "living" and the Greek Septuagint translates it with *Zoe*. Other scholars, connecting the word with the Hebrew *Hayy*, or clan, see in it a personification of the idea of mother-kinship or descent from a common mother. The story of Eve as told in the Bible is to be understood in connection with the context of the Garden of Eden stories. See *GENESIS*.

EVELETH, a city in St. Louis Co., northern Minnesota, situated 60 mi. northwest of Duluth. Bus lines and two railroads serve the city. Eveleth lies in the Mesabi Range region almost surrounded by deposits of iron. The first ore was discovered in 1892. Underground mining, at first used, later gave way to the open pit system. Hay and potatoes are raised in the vicinity. Pop. 1920, 7,205; 1930, 7,484.

EVELYN, SIR JOHN (1620-1706), English diarist, was born at Wotton, near Dorking, Oct. 31, 1620. He was educated at Oxford, and studied law. To avoid signing the Covenant he traveled for four years in Europe. After the Restoration he was active both at court and as a writer. He produced some 35 works, upon various subjects. Among these are *Sculpture* and *Sylva*, on forest trees. Evelyn's fame, however, rests upon his diary, which was discovered at Wotton in 1817 in an old clothes-basket. It covers the years from 1640-1706, and includes many important events. Without Pepys' (see *PEPYS, SAMUEL*) delight in intimate personalities, Evelyn gives the observations of an upright, intelligent man, active in affairs and society. He died at Wotton, Feb. 27, 1706.

EVENING-PRIMROSE, the common name of a numerous genus (*Oenothera*) of the evening-primrose family, comprising nearly 100 species native chiefly to North America. They are leafy branching herbs sometimes shrubby at the base, with alternate leaves and usually showy yellow, white or rose-colored flowers. The common evening-primrose (*O. biennis*),



FROM JEPSON. MAN. FL. PLANTS CALIF., COPYRIGHT

LARGE-FLOWERED EVENING-PRIMROSE
(*Oenothera Hookeri*). A showy Californian species. Flowering stem, capsule and leaf

a biennial grown in gardens, is a common wild flower east of the Rocky Mountains, and is widely naturalized as a weed in Europe. The stoutish stems, 3 to 4 ft. high, bear light green leaves, and large, fragrant yellow flowers which open shortly before sundown. A similar cultivated species (*O. Lamarckiana*), of unknown origin, was used by DeVries in his experiments in mutation.

EVENING SCHOOLS are intended primarily for those who are unable because of the necessity of earning their living to attend day schools. Instruction is given in elementary and high school subjects, and vocational or industrial training is provided. Diplomas equivalent to day school diplomas are given by some of the evening schools. Many evening classes

CENTRAL EUROPE
(Including Figures from Latest Population Estimates)

ALBANIA
Area 17,374 sq. m.
Pop. 1,003,077
PRINCIPAL CITIES
Pop.—Thousands
31 Tirane... M 13

AUSTRIA
Area 32,360 sq. m.
Pop. 6,726,113
PRINCIPAL CITIES
Pop.—Thousands
1866 Wien... H 9

BULGARIA
Area 39,814 sq. m.
Pop. 5,944,000
PRINCIPAL CITIES
Pop.—Thousands
213 Sofia (Sofia) L 17

CZECHOSLOVAKIA
Area 54,192 sq. m.
Pop. 14,726,158
PRINCIPAL CITIES
Pop.—Thousands
125 Moravská-Ostrava... F 11
848 Praha (Prague)... F 7

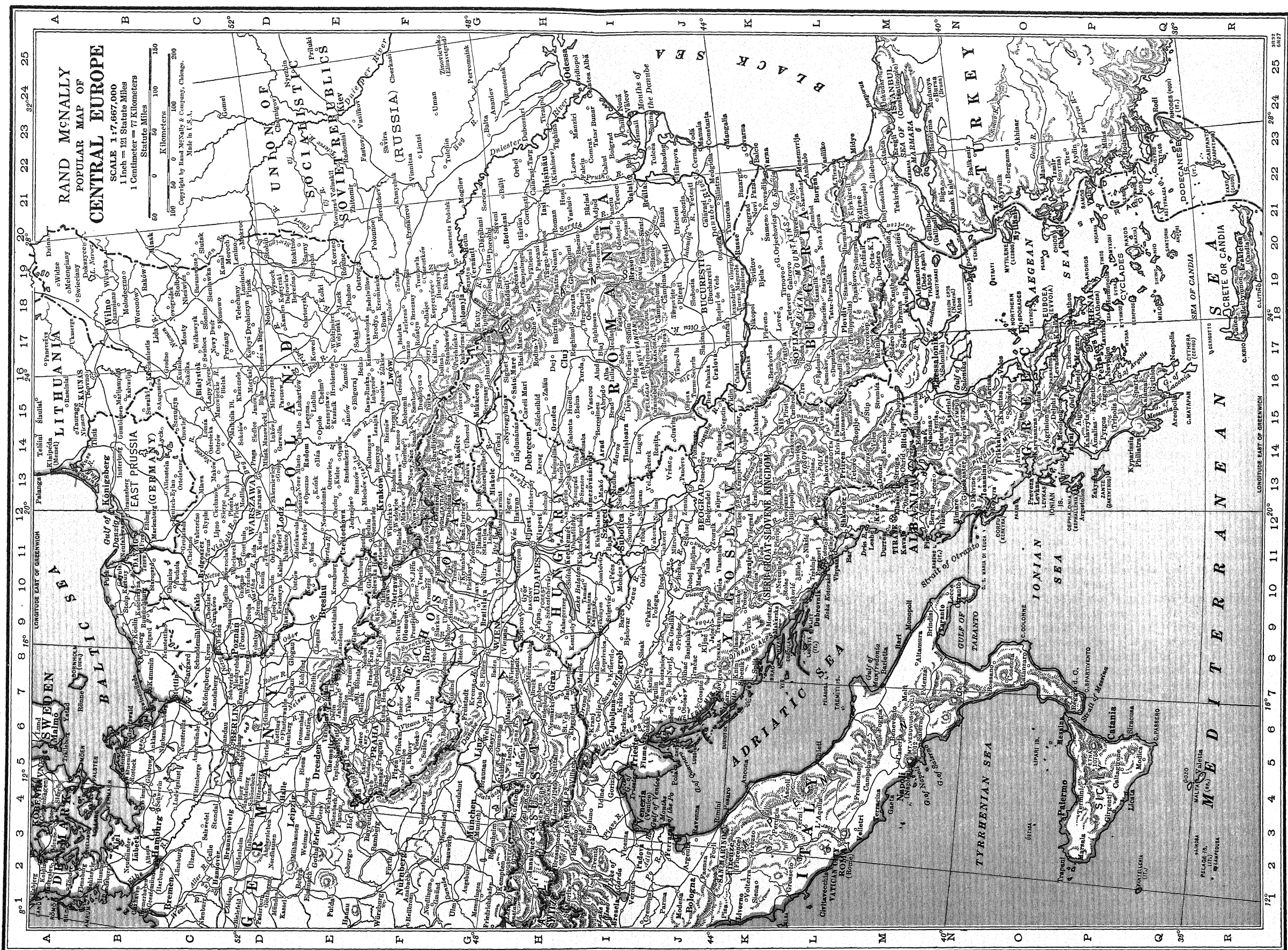
HUNGARY
Area 35,875 sq. m.
Pop. 8,683,740
PRINCIPAL CITIES
Pop.—Thousands
1005 Budapest... H 12

GREECE
Area 54,092 sq. m.
Pop. 6,315,000
PRINCIPAL CITIES
Pop.—Thousands
453 Athenai (Athens) P 18
28 Mytilini... O 22

POLAND
Area 149,915 sq. m.
Pop. 31,704,000
PRINCIPAL CITIES
Pop.—Thousands
1109 Warszawa (Warsaw) D 14

ROMANIA
Area 122,282 sq. m.
Pop. 18,176,757
PRINCIPAL CITIES
Pop.—Thousands
85 Arad... I 14
875 Bucuresti (Bucharest) K 20

YUGOSLAVIA
(Serb-Croat-Slovene Kingdom)
Area 96,134 sq. m.
Pop. 13,930,918
PRINCIPAL CITIES
Pop.—Thousands
242 Beograd (Belgrade) J 14



are held in universities as part of their extension work.

Evening schools in the United States were started as private enterprises as a result of the requirement that all apprentices should be given an education by their masters. Masters complied with this by sending apprentices to evening schools, thus not interfering with their work. These private schools had existed over 30 years before the general movement to open them as public institutions. Though the exact date of their origin is unknown, there were several in existence before 1800. In 1773 one was opened in Salem, Mass., for teaching marine arts, arithmetic and writing to poor boys, and in 1797 an evening school for colored pupils was opened in Philadelphia. In 1823 the New York Public School Society permitted teachers to hold evening sessions, and 10 years later evening schools became part of the day school system. The first evening school in San Francisco opened in 1856. The following year the State legislature of Massachusetts authorized support of evening schools, and in 1861 the Chicago Board of Education established an evening school. In 1866 New York opened an evening high school, and other large cities included them in their public school systems within a few years. There has been a steady growth of evening schools since 1900, these being established in most cities of 100,000 or over and in many of the smaller cities. M. R.

EVE OF ST. AGNES, THE, a narrative poem by JOHN KEATS; published 1820. The beautiful Lady Madeline, obeying the dictates of an old superstition, goes supperless to bed on St. Agnes' Eve, hopeful thus to see her future husband in a dream. She is gently awakened in the middle of the night by her lover Porphyro, who has been admitted to her room by an old serving-woman, and is gladly persuaded by him to elope from her castle.

EVERAERTS, JAN NICOLAI. See SECUNDUS, JOHANNES.

EVEREST, SIR GEORGE (1790-1866), English geographer and surveyor, born July 4, 1790 at Gwern-dale. He assisted in the surveys by Colonel Lambton and continued these after Lambton's death until 1843, when he retired and returned to England. His work in geodesy, described in *An Account of the Measurement of Two Sections of the Meridional Arc of India* (1847), was considered a superior accomplishment. Everest was made a knight (1861). Mount Everest bears his name. He died Dec. 1, 1866.

EVEREST, MOUNT, a mountain of India, the highest in the world (29,141 ft.), situated in Nepal in 28° N. lat. and 87° E. long. The peak was named in honor of Sir George Everest, who surveyed it in 1841 and first fixed its position.

In the southeast of the Himalayas the highest group of mountains on earth is to be found gathering around Everest, which is itself only one peak among a number of surrounding satellites so little inferior to it in height that when its altitude was first observed trigonometrically it was not selected as the

most conspicuous. The summit of Everest has not yet been reached by man. Attempts have been made many times, and elaborate expeditions by British explorers in 1921, 1922 and 1924 and by German and British mountaineers in 1929 reached within several hundred feet of the top. The difficulty of breathing is the most obvious of the physiological difficulties involved in an ascent to so great a height. A loss of muscular power, or glacier lassitude, is also experienced above 20,000 ft. A sheet of ice, a hot sun and a still air will bring about this condition. The sun melts the superficial layer of ice, and the lowest stratum of the atmosphere becomes saturated with moisture but does not rise owing to its being chilled by contact with the ice. Thus, when on a glacier the climber is in a saturated atmosphere, and this, in conjunction with the high altitude, is sufficient to cause unpleasant effects. Some mountaineers state that the use of the oxygen apparatus relieves the breathing and diminishes the tiredness of the legs, while others say that it gives no relief.

EVERETT, ALEXANDER HILL (1790-1847), American author and ambassador, was born in Boston, Mass., Mar. 19, 1790. After graduating at Harvard he began to study law in the office of JOHN QUINCY ADAMS, through whom he obtained various diplomatic appointments in Europe. He is the author of *Europe, or a General Survey of the Political Situation of the Principal Powers with Conjectures on Their Future Prospects*, a similar study, *America, and New Ideas on Population*. Everett died in Canton, China, May 29, 1847.

EVERETT, EDWARD (1794-1865), American educator and statesman, was born at Dorchester, Mass., Apr. 11, 1794. After his graduation from Harvard in 1811 he studied for the ministry and in 1814, the year of his award of an M.A. degree, he became the minister of the Brattle Street Church in Boston, one of the largest and most fashionable Unitarian churches in the city. In 1815 he accepted the newly established chair of Greek literature at Harvard and sailed for Europe where he remained four years preparing himself. In 1817 he received the first Ph.D. degree ever awarded to an American at Gottingen. In 1819 he began to teach at Harvard and also acted as editor of the *North American Review*. Everett early acquired a reputation for magnificent eloquence and in 1824 he was elected as an independent to the U.S. House of Representatives where he served from 1825 to 1835. In Congress he was essentially conservative, supporting the bank and tactfully yielding to Southern sensitiveness on the slavery question. By a combination of Whigs and anti-Masons, he was elected governor of Massachusetts in 1835, serving four terms, 1836-39, and being defeated for reelection the latter year by a single vote. A state board of education and a system of normal schools were created during his administrations. Everett was minister to Great Britain, 1841-45. For four months at the close of Fillmore's administration he was Secretary of State, 1852-53, and in 1853 he was elected

to the U.S. Senate by the Whig-controlled Massachusetts legislature.

Everett's moderate attitude towards the slavery controversy and his emphasis upon the need of a continued Union became unpopular in the rising tide of anti-slavery sentiment in Massachusetts and when illness prevented him from voting on the Kansas-Nebraska Act, 1854, he was accused of purposely absenting himself. Everett had spoken against the bill in calmer terms than had Sumner and resentful of the charge he resigned from the Senate. He deplored the heated anger of the slavery quarrel and believed the maintenance of the Union of prior importance. In 1860, he was the vice-presidential candidate of the Constitutional Union Party which obtained the third largest number of electoral votes and polled the fourth and lowest number of popular votes. With the outbreak of the Civil War he heartily supported the national government and though an old man he delivered innumerable speeches which exhorted the North to bring the war to a victorious conclusion. At the dedication of the national cemetery at Gettysburg, Nov. 19, 1863, he delivered a lengthy oration before Lincoln's brief but exquisite *Gettysburg Address*. In 1864 Everett vigorously advocated the reelection of Lincoln. He died in Boston, Jan. 15, 1865.

EVERETT, a city in Middlesex Co., eastern Massachusetts, situated on the Mystic and Malden rivers, 3 mi. north of Boston. It is served by the Boston and Maine Railroad. The chief local manufactures are shoes, chemicals, coke, gas, petroleum products and steel. In 1929 the industrial output was valued at \$78,218,918. The retail business of Everett in 1929 amounted to \$11,874,536. Everett was settled about 1630. Before incorporation as a town in 1870 it was known as South Malden. It became a city in 1892. Pop. 1920, 40,120; 1930, 48,424.

EVERETT, a city and inland port in northwestern Washington, the county seat of Snohomish Co., situated on Puget Sound at the mouth of Snohomish River. It is served by ocean-going and coastwise steamers and three railroads. The city is an important shipping point for lumber and other products; great quantities of floating logs pass through this harbor. The vessel traffic for 1929 amounted to 1,369,939 tons, worth \$21,837,711; the floated lumber amounted to 1,122,990 tons, worth \$6,176,445. Everett has a variety of lumber mills, a large paper factory, iron and steel works and other industrial plants. In 1929 the manufactured output was valued approximately at \$23,000,000; the retail trade amounted to \$22,002,134. Settlement began in 1891; Everett was incorporated in 1893. Magnificent scenery surrounds the city. Capt. George Vancouver, the English explorer, visited a spot just west of here in 1792. Pop. 1920, 27,644; 1930, 30,567.

EVERGLADES, the swampy region of southern Florida, occupying most of that state below the latitude of Lake Okeechobee. It is a low, flat basin covering approximately 4,000 sq. mi., almost enclosed by ridges of limestone, in which there is a thick accumu-

lation of black muck or peat. The surface is a vast saw-grass marsh bordered by cypress and mangrove swamps and interspersed with islands covered with rich jungle. On these islands the Seminole Indians



THREE SEMINOLE BOYS OF THE FLORIDA EVERGLADES

have cleared small areas for their crops. Because of the excessive fertility of the soil, the Everglades are being reclaimed by drainage canals for agricultural purposes.

EVERGREEN, in botany, the name applied to perennial plants, especially to trees and shrubs, whose leaves do not mature and fall off at the end of the first growing period, but persist for two or more seasons, being replaced during spring and summer, so that the foliage remains green throughout the year. Coniferous trees are mostly evergreen in all climates; among exceptions are the larch and bald cypress. Broad-leaved trees are usually deciduous in temperate regions, though some, as the box, holly and cherry-laurel, are evergreen. The species of broad-leaved trees native to the tropics are largely evergreen.

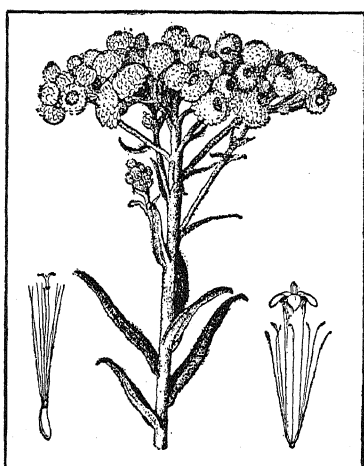
EVERLASTING, the name given to various plants of the composite family bearing flowers which retain their form and color for long periods after drying. The cultivated everlastings, often called immortelles, are chiefly Australian species of *Helichrysum*, *Ammobium* and *Helipterum*. The pearly everlasting (*Anaphalis margaritacea*) is native to dry soils from Newfoundland to California and northwestward to Alaska. Various North American species of *Antennaria* and *Gnaphalium* are called everlasting.

EVERLASTING PEA (*Lathyrus latifolius*), a smooth, climbing, long-lived perennial of the pea family closely allied to the SWEET PEA. It is a native of Europe widely cultivated for its profuse pealike flowers varying from purple to white and sometimes to darker colors.

EVERYMAN, a morality play of unknown authorship, first produced in England probably between 1520 and 1530, depicting the journey of "Everyman" through life to the gates of death. The

play has for its chief characters such personifications as "Good Deeds," "Conscience," "Religion," through whom it points its moral lessons.

EVERY MAN IN HIS HUMOUR, the first extant comedy by BEN JONSON; played, with SHAKE-



FROM JEPSON, MAN. FL. PLANTS CALIF., COPYRIGHT

PEARLY EVERLASTING

Upper part of stem with flattened cluster of flowering heads; also (left), single pistillate flower, and (right), staminate flower.

SPEARE in the cast, in 1598; first printed, 1601. This, perhaps the most vital of Jonson's plays, deals with a group of people who are duped by their special "humors." The principal characters are Kately, whose humor is jealousy; Dame Kately, a prey of the same humor; Knowell, who is excessively suspicious; Stephen, betrayed by stupidity; and the braggart, Captain Bobadil. The play was revised and very successfully presented by the famous English actor, DAVID GARRICK, in 1749.

EVESHAM, BATTLE OF (1265), an engagement at Evesham, Worcestershire, England, which ended the BARONS' WAR, 1264-65. The Earl of Leicester was marching towards Kenilworth to effect a junction with his son, Simon de Montfort, but was overtaken on Aug. 4, by the Royalist army under Prince Edward and surrounded by them in a fork of the river Avon near Evesham. The earl attempted to cut through the prince's lines but failed. He made a last stand on the summit of a hill, where his companions formed a solid circle about him. All the barons and knights, about 180, were killed, and Leicester's body was brutally mangled.

EVIDENCE, in law, the testimony or documents by which facts are established or disproved. Besides the testimony of witnesses, evidence may be given by producing writings, fingerprints and articles alleged to have been used in the commission of the crime under question. When a witness testifies that he has seen or heard something, that is *direct evidence*. *Circumstantial evidence* is that which tends to prove a fact as an inference from conditions; e.g., proof of fingerprints found at the scene of the crime to establish the guilt of a thief who stole jewelry

although no one saw him commit the crime. Restrictions on what may be offered as evidence are embodied in rules which have grown out of experience of what juries and triers of fact may properly consider. These rules concern what is to be received or rejected and are especially intended to keep out that which is immaterial and irrelevant to the subject at issue. The court may, without evidence, take judicial notice of certain well known facts.

EVIDENCE, PSYCHOLOGY OF. By reason of their application to legal procedure, the processes involved in the giving of testimony have been subjected to special investigation by psychologists. Witnesses differ in competence in each of the steps that enter into a report or testimony. They may be enumerated as (a) errors of perception; (b) errors of memory; (c) errors of judgments under various influence of bias, fear, self-interest, suggestion. The question of intentional deception or concealment of guilt may be separately considered.

Estimates of time, distance, number, rate of movement and the exact sequence of incidents are notoriously inaccurate. Yet upon these details verdicts may depend. The time for showing a motion-picture scene, actually 60 seconds, was estimated as from 10 to 400 seconds. Fifty spots on a card were estimated as from 25 to 200; even with only 20 spots, the range was from 10 to 70. The speed of a hand moving around a dial, actually four inches per second, was described as the rate of a snail, a man walking slowly, a bicycle rider, an express train, or from 7 to 40 miles per hour. Estimates of the speed of passing automobiles varied as widely.

These variations are not as serious as those due to defective memory. In reporting upon the motion-picture, only from 30 to 40 per cent of the essential facts shown were recalled at all, and only from 20 to 30 per cent correctly, in spite of the fact that in laboratory tests the attention is favorable. The error in recall increases rapidly with the interval between the event and the report upon it. Yet many important facts in legal evidence depend on casual or incidental observation, when there is no effort upon fixing the incidents for recall. Reliable witnesses, with good observation and accurate memories, are the exception.

Such studies of isolated factors indicate the wide ranges of error under more artificial circumstances than generally apply. The matter of identifying suspected persons, of describing where a fire started, which one of two assailants struck first, what words were spoken and by whom, is more complicated, and thus subject to larger error. To test the matter there was staged in a classroom at the University of Berlin a violent altercation between two students amid general uproar; the professor separated them and a revolver went off. The students, accepting the incident as real, wrote their reports, with the result that the best observer had 26 per cent of his statements false, and the worst 80 per cent. Still more strikingly, at a meeting of scientific men, a clown in bright array and a Negro entered the room; a shot was heard; one

of the men fell and the other jumped on him. The incident occupied 20 seconds. Of the 40 reports which were prepared, only one omitted less than 20 per cent of the essential factors, and some more than 50 per cent. Only six of the 40 statements were free of error. Only four of the 40 noted that the Negro was bareheaded; others described his hat as a derby, a high hat, or some other style. His black coat, white trousers and large red necktie were described as a red suit, a brown one, striped, or no coat at all.

That witnesses are readily confused and respond to the suggestions or the threats or insinuations contained in questions is familiar. The difference between asking, "Was there a moonlight, or commotion?" or whatever the item, and, "Wasn't there?" shows the higher value of the negative form of question. It likewise appears in this, as in the former group of experiments, that items testified to with great confidence are hardly more reliable than statements given with less confidence. Confidence is a matter of personal temperament. The manner, hesitation, embarrassment and contradiction so often interpreted as a tendency to withhold or falsify evidence may equally indicate the dread and excitement of the occasion.

This raises the issue of guilt or deception and their psychological detection. Methods brought to bear upon this issue include (a) the association method of giving clue or critical words scattered among a list of neutral words, and judging from the delayed, unusual, blocked associations when the subject responds to the stimulus word by some word which it calls up; (b) registering the pulse, blood pressure and respiration while the associations are given; (c) exhausting the subject by persistent questions, intimidation, appeals or other devices to break down resistance. The results indicate that while each of these methods may prove successful in some cases, the individual variability is too large to give any one method a high degree of reliability.

J. J.

See H. Muensterberg, *On the Witness Stand*, 1908; A. T. Poffenberger, *Applied Psychology*, 1927.

EVIL EYE, an eye which, according to an ancient and widespread belief, carries a blighting influence, whether by curse of nature or with malicious intent. The use of this power is one form of casting spells or WITCHCRAFT. Various drugs were used to counteract the evil eye, and charms were worn to avert the influence. The belief survives especially in the Orient and southern Europe. The Italian name is "malocchio." *The Evil Eye*, by F. T. Elworthy, presents a comprehensive survey of the belief and the practices associated with it.

EVOLUTION, in philosophy, the theory that things have gradually come to be what they are by a determinate process of development. It is a philosophy of change and is opposed to special creationism. The idea of change is not new in philosophy; it is as old as Heraclitus. Nor is the conception of development particularly new, for it is very definitely Aristotelian. (See ARISTOTLE.) Conceptions of evo-

lution, however, have been influenced primarily by the findings of modern science, particularly in the realm of organic nature. It was in the field of astronomy that evolution found its first application. Here in the conception of the nebular hypothesis as formulated by Laplace were erected its early forts. The work of Lyell applied the idea to the earth. Although there had been hints of its application to the domain of life, as in the work of BUFFON and LAMARCK, to CHARLES DARWIN must be given the credit for having established in his *Origin of Species*, 1859, the great generalization that threw the spotlight on evolution. Benjamin Kidd applied the conception to society, and finally Herbert Spencer's majestic vision of an evolutionary theory compassed the whole universe and all things therein.

Since Darwin was the storm center, much of the discussion since has centered about his five links in evolution. He started with the principle of the (1) prodigality of nature. Nature produces more species than can possibly survive, and this gives rise to (2) struggle. Selection takes place on the basis of (3) variations which better adapt the species to its surroundings. Variations occur around a mean. Nature (4) selects those variations which are most useful and, by means of (5) heredity, which means that variations tend to cluster round the parent stem, passes them on from generation to generation.

Lamarck had argued that the development of organs was due to their functioning, and their disappearance to disuse. Weismann showed that only congenital variations could be transmitted, and that acquired characteristics have no effect upon the germ plasm. Much more time would be required for evolution to run its course with only the hereditability of congenital variations. But this has been partly offset by the mutation theory of De Vries, which emphasizes the rôle of biological sports. Most of the controversy has centered about the nature and cause of variation and also of heredity.

Although all recent philosophy has been greatly influenced by the concept of evolution, only those which are definitely philosophies of evolutionism will be noted. Among these are the materialistic evolution of Haeckel, the creative evolution of Bergson, the emergent evolution of Lloyd Morgan and S. Alexander, the holistic evolution of Smuts, the evolutionary naturalism of Sellars, the spiritualistic evolution of Fiske and Boodin and the purposive evolution of Noble and Hobhouse. At the two extremes are the materialistic and the spiritualistic views. Between these the holistic and emergent views offer a compromise. The emergent recognizes different levels of evolution, such as matter, life and mind. These are ordered according to the principle of logical priority. Holism and evolutionary naturalism emphasize the process rather than the level of development, recognizing the principle of creative synthesis. Creative evolution is definitely vitalistic, stressing the rôle of intuition and the mystical development of the *élan vital*. Purposive evolution is more closely connected

with spiritualistic, but is definitely excluded only by the materialistic point of view. *See also* ORGANIC EVOLUTION.

BIBLIOGRAPHY.—H. H. Newman, *The Gist of Evolution* (1926); G. P. Conger, *New Views of Evolution* (1929).

EVOLUTION, MATHEMATICAL, a name formerly, and often at present, given to that part of arithmetic which treats of the finding of a root of a number. *See* Root.

EVORA, capital of the Portuguese district of the same name, southeast of Lisbon, was a military station of the Romans during the first century of the Christian era. Under its ancient name of *Ebora*, the city was the seat of a bishopric while the West Goths were in occupancy, but fell to the Moors in 712 and was not recaptured until 1166 by an order of knights. There Dom Miguel was forced to abdicate in May 1832. A Gothic cathedral rose in the 14th century in restoration of a 12th-century Romanesque edifice. There are other fine churches and palaces within the city walls and a Roman fortress overlooks the narrow, picturesque streets and squares. As the seat of an archbishop, Evora has an archiepiscopal palace. There is an archaeological museum, library and lyceum connected with the former Jesuit university, 1551-1759. Nearby is a Roman aqueduct and ancient cloisters. The chief manufactures are textile and leather goods; trade is mostly in grain and wine. Pop. 1920, 16,148.

EVREUX, a town in Normandy, capital of the department of the Eure. Its cathedral combines several styles of architecture, and contains stained glass dating from the 13th to the 17th century. With some fragments of a 12th century building, the body of the church dates from the 13th century; but the lateral chapels were added in the 14th, the transept in the 15th, and the façade in the 16th century. At the latter period much of the structure was rebuilt. The chapels have magnificent screens of carved wood, of the 16th century. Evreux is the center of an important grain district. Pop. 1931, 19,315.

EWALD, JOHANNES (1743-81), Danish poet and dramatist, was born at Copenhagen, Nov. 18, 1743. He entered the University of Copenhagen at 15, but soon ran away to join the Prussian army in the Seven Years' War. The hardships of military life had undermined his health, but he wrote many dramas, which are important chiefly for the lyric poems contained in them. His poem, *King Christian Stood by the Lofty Mast*, which has become a national song, appeared in his drama, *The Fishermen*. Ewald died at Copenhagen, Mar. 17, 1781.

EWING, SIR JAMES ALFRED (1855-), British physicist, was born at Dundee, Scotland, March 27, 1855. During 1878-83 he was professor of mechanical engineering at the University of Tokio. He was successively professor of engineering at University College, Dundee, and at Cambridge. In 1903 he was appointed director of naval education to the British Admiralty. In 1911 he was knighted and in 1916 he resigned from the Navy, becoming vice-chancellor of the University of Edinburgh, remaining

in this post until 1929. Ewing's principal work was in the field of magnetism. He modified certain of the standing theories, notably those concerning the permeability and thermoelectric properties of metals. He discovered the phenomenon of magnetic hysteresis.

EWING, THOMAS (1789-1871), American statesman, was born near West Liberty, W.Va., Dec. 28, 1789. He was graduated from Ohio University and began practicing law at Lancaster, Ohio, in 1816. As a Whig member of the U.S. Senate from 1831-37 he threw himself into the fight to secure a new charter for the United States Bank. This institution had been established by Hamilton to gain the confidence of people in the stability of the new Colonial Government but at this time, many politicians claimed that its resources and prestige were being used to further personal and political advancement by those in power and it was the issue which elected Jackson to the Presidency. President Harrison appointed Ewing Secretary of the Treasury in 1841, and in 1849, President Taylor made him secretary of the newly established Department of Interior, a position from which he resigned to finish Thomas Corwin's term in the Senate in 1850-51. He died at Lancaster, Oct. 26, 1871.

EXAMINATIONS, as used in the educational field, are tests of the knowledge or intelligence of students. Until the increasing number of students made the oral examination impractical, this was the method used in the United States. Though this has not been discarded, it is now ordinarily used only to supplement other types of examinations. The written examination took the place of the oral examination in Boston in 1845 and has been generally accepted. The written examination, however, has gone through several important changes. In its first form, it was an essay type in which the student had to write articles of varying length on given topics. Standardized tests and scales were developed about 1910, and these are now in general use throughout the country. These tests, instead of consisting of five to ten questions, as in the essay form of examination, include 50 to 100 items which can be answered by a mere word or phrase or by crossing out or checking a part of the statement. They thus cover a wider range of the subject than the old method. These examinations are generally classified as true-false, multiple choice, recall or matching tests. The results of the examinations are easily checked by the examiners and do not permit any variation in marking dependent on the judgment of the teacher. Intelligence tests were introduced in the schools in America in 1911 and have been used extensively to supplement other examinations.

See A. R. Lang, *Modern Methods in Written Examinations*, 1930.

EXAMINATIONS, COLLEGE ENTRANCE. Until 1901 colleges and universities in the United States held all entrance examinations at their own institutions. These varied widely in the field covered, which created a difficult problem for the secondary schools in trying to fit students to meet their

requirements. In 1891 a group of representatives from colleges and secondary schools had been authorized by the National Council of Education to work out some plan of standardized examinations, and in 1899 the College Entrance Examination Board was organized to develop a definite program for preparation of such examinations. In 1901 the first examinations were held by this board in 67 widely separated cities in the United States. The questions were prepared and the papers corrected by committees of high school teachers and college professors appointed by the board. Fifteen colleges cooperated in this first attempt. In 1929 these examinations were held in 357 centers in the United States and several places abroad. Most of the principal colleges and universities have now adopted this method of examinations. Supplementary examinations for those who may have failed in some subject in the board's examinations in June are held in the fall at the individual universities.

See College Entrance Examination Board, *Annual Reports*.

EXARCH, Byzantine title of the governor of a province, especially, in the eyes of the Western World, the exarchate of Ravenna, which after the destruction of the Ostrogothic realm in 555, embraced all of Italy, but slowly lost territory to the Lombards over a period of about 500 years. In the 8th century the exarchs resided in lower Italy until Sicily was occupied by the Saracens. In 1071 their last Byzantine fortress in Italy was taken by the Normans.

The title exarch was also frequently used to designate the metropolitans of the ancient Church and at times also certain super-metropolitans. In the Middle Ages the term was a mere title without clearly defined rights. The primate of the Bulgarian Church has held the title of exarch since the break with the patriarchate of Constantinople.

EXCALIBUR, in the ARTHURIAN LEGENDS, the matchless sword which King Arthur, early in the romance, draws forth from a stone in which it has been miraculously embedded, and which is given him, later in the romance, by the Lady of the Lake, at Merlin's bidding. Supernatural power dwelt in this marvelous weapon which, just before his death, Arthur gives back to the Lady of the Lake.

EXCAVATING MACHINERY comprises: for loosening earth, plows; and for handling earth, scrapers on small jobs; wagons and motor trucks, or dump cars on narrow-gauge track, loaded by power shovels, for larger work. Large pits, canals, etc., are often excavated by DRAGLINE EXCAVATORS or BUCKET EXCAVATORS. Dredges of various types are used for work under water. See also DREDGING; GRADING MACHINES; MATERIALS HANDLING; POWER SHOVELS; SCRAPERS; STRIP MINING; TRENCHING MACHINES.

EXCELSIOR SPRINGS, a city in Clay Co., northwestern Missouri, situated 25 mi. northeast of Kansas City. Grain, cattle and hogs are the leading interests of this region. The city has many medicinal mineral springs, making it a year-round health resort. There are coal mines in the vicinity. Excelsior Springs was

founded in 1880; incorporated in 1889. Pop. 1920, 4,165; 1930, 4,565.

EXCEPTIONS, BILL OF. See BILL OF EXCEPTIONS.

EXCESS PROFITS TAX. Taxation of excess profits under laws specifically designed for this purpose rather than under income tax laws of general application, was introduced in a number of countries during the World War. In addition to the desperate need for revenue, the motive was that of capturing a portion of the excess profit which was emerging from the extensive industrial and commercial operations that were stimulated by the war demand. Since the abnormal or excessive profit was a result of the war conditions, unusually severe TAXATION was considered justifiable, and special tax legislation was enacted to set up the procedure.

The determination of an excess profit involves serious administrative difficulties. In order to be excessive, the profit must be more than the normal or customary return on the CAPITAL invested. The Federal law did not undertake to fix a flat rate of profit which should be regarded as the base above which excess profits should be measured. Instead, differences in profit return were recognized by providing that excess profit, in the case of each individual taxpayer, should be the profit in excess of the average profit of the three years preceding the war, with an adjustment for differences in the invested capital. The rates were steeply progressive, the progression being based on the relation of the excess profit to the invested capital. The determination, for each of the thousands of concerns subject to this tax, of the proper amount of invested capital, the proper pre-war income, the actual changes in invested capital between the pre-war period and the taxable year, and other equally perplexing problems, was an administrative task of tremendous difficulty. The tax was very productive, since the excess profits arising out of all industry in war time were enormous. In view of the administrative difficulties and of the shrinkage of profits to the level normally established under peace conditions, the special excess profits taxes were repealed.

The excess profits tax is a useful fiscal instrument for abnormal conditions. It is of doubtful value in the permanent tax structure under normal circumstances.

H. L. L.

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EXCHANGE, a term which may cover almost any transaction in which two or more persons transfer, each to the other, articles which can be described. Economists and business men use the word, however, to indicate an exchange of money; and, particularly, an exchange of units of the currency of one political area for units of the currency of another such area. Thus money of the United States may be exchanged for that of England, France or Germany. The practice of exchange in this sense may arise from

travel, or from the necessity of making payment in foreign jurisdictions to settle commercial or political obligations. Generally speaking, coins of different countries exchange for each other in a ratio which corresponds to their relative bullion content in pure gold or pure silver, or, when one country uses a gold and another a silver standard, upon a basis which takes account also of the relative market prices of these metals. It is not always necessary, however, to purchase and ship foreign money merely because one wishes to make payment in a foreign country. Modern banking machinery enables a debtor to pay a certain amount of, say, United States money in New York, and to receive a credit in French money in Paris upon which he can draw without actual transportation of the cash. In such a case the amount of money which it will be necessary to pay in the United States in order to receive a stated number of francs in Paris will fluctuate according to the demand for transfers of this character between the countries, as well as according to the relative bullion content of French and American gold coins. *See also FOREIGN EXCHANGE.* S. D.

BIBLIOGRAPHY.—E. S. Furnise, *Foreign Exchange*; A. B. Cook, *Financing Exports and Imports*.

EXCHEQUER, traditional name for the revenue department of the United Kingdom, derived from the checkered tablecloth upon which were computed the revenues in the king's counting house organized in the reign of Henry I. By the reign of Henry II the chief officials were represented by deputies; one of these, the chancellor's clerk, developed into the Chancellor of the Exchequer, now the Chief Finance Minister of the crown. Additions and changes were made, notably under the Tudors and Stuarts, but the cumbersome and obsolete medieval procedure was abolished in its entirety only by the Exchequer Act of 1834. Previous to 1787 it was usual for the proceeds of each source of revenue to be earmarked for expenditure on some particular purpose. This cumbersome system was ended when the act of 1787 created exchequer accounts at the Banks of England and Ireland (Belfast), administered by the banks practically as if they were ordinary commercial accounts. Into these accounts are gathered, with a few exceptions, all the revenues of the Crown. The fund which is thus formed is called the Consolidated Fund and is under the control of a salaried officer who is known as the Comptroller and Auditor General. From the Consolidated Fund practically all government expenditures are made. There are two classes of such payments. First, the consolidated fund services, which are such standing government obligations as the civil list, judges' salaries, national debt charges and the like. Each of these fixed annual expenses are authorized by a single act of parliament. Secondly there are the supply services, consisting of such variable expenditures as education, army, navy and other services which reflect the policies of the government in office. These are authorized by Parliament afresh each year by means of an appropriation act.

The Exchequer should not be confused with the Treasury, which is the department, with the Chancellor of the Exchequer as its political head, that prepares, for the sanction of Parliament, estimates for expenditure and proposals for raising revenue. This department also supervises the finances of the various spending departments of the government.

BIBLIOGRAPHY.—W. F. Willoughby, W. W. Willoughby and S. M. Lindsay, *The System of Financial Administration of Great Britain*, 1917; R. Hawtrey, *The Exchequer*, 1921.

EXCHEQUER BILLS. In 1696 the British Government began the practice of raising a short-term loan for expenditure on a specific purpose, in anticipation of revenue to be raised by act of Parliament for the same purpose. Paper issued for such loans were called exchequer bills. They were passed from hand to hand as if they were currency and were accepted in payment for taxes. The government would change the rate of interest from day to day, raising it when large quantities were being used for paying taxes, so that it would become profitable for holders to pay in currency. The last issue of exchequer bills was in 1861. Their place has now been taken by exchequer bonds and treasury bills.

BIBLIOGRAPHY.—R. Hawtrey, *The Exchequer*, 1921; Henry Higgs, *The Financial System of the United Kingdom*.

EXCISE, *see* INTERNAL REVENUE.

EXCITATION, the magnetization of the fields of a dynamo (*see* DYNAMO ELECTRIC MACHINE). One of the essential parts of a dynamo is the field, or ELECTROMAGNET, which produces the magnetic flux in which the conductors of the ARMATURE rotate. This field is energized, or excited, by supplying its coils with a current from some suitable source, either the armature of the same machine or a source entirely separate from the dynamo. When a separate machine is used for this purpose, it is called an *exciter*. The process of exciting the field is called excitation.

A self-excited dynamo may be shunt-wound, series-wound or compound-wound. A shunt-winding comprises coils about the field poles which are so connected to the armature that only a portion of the total current generated passes through them. At constant speed the electromotive force of a shunt-wound dynamo decreases with increasing load. A series-winding comprises field coils so connected that the total current generated by the dynamo passes through them. At constant speed, the electromotive force of a series-wound dynamo increases with increasing load. A compound-winding contains both shunt and series coils which, if properly proportioned, will hold the dynamo electromotive force practically constant over wide load ranges. L. B. S.

EXCLUSION BILL, a measure proposed, 1680, but rejected by the House of Lords, whereby James II, being a Roman Catholic, would have been debarred from the throne. *See* BILL OF RIGHTS; PROTESTANT SUCCESSION.

EXCOMMUNICATION, a ban or taboo on individuals or communities which can be traced to the earliest days of the race. The Greeks, Romans, Druids

and Jews were familiar with it. Among the Jews, exclusion from the synagogue is a recognized penalty, of which Spinoza's excommunication in 1656 is perhaps the most notable example in recent centuries. The Anglican Church possesses the right, subject to an appeal to the throne, but has never exercised it. Most Protestant bodies have transformed it into church discipline, by which members are expelled by the responsible authority. In the Catholic Church it has been most common, and may be exercised as a penal correction against nations and individuals by the popes, by general and provincial councils and by bishops in their respective spheres of influence. There are two kinds of excommunication, major and minor. Major excommunication is exclusion from the communion or eucharist, a serious penalty in the eyes of the Church. Minor excommunication is the deprivation of certain benefits of the Church, as the sacraments. From 380 A.D. until medieval days, however, with the promulgation of imperial edicts against heresy, excommunication often involved temporal dangers, until it was removed by jurisdictional, not sacramental absolution. The excommunicated do not cease to be Christians, as baptism is not abrogated, and absolution simply restores rights taken away.

EXCRETION, the elimination from the body of *waste products* coming to an organ by way of the blood stream in a preformed state. If a gland or organ forms compounds by synthesizing them from *precursors* which reach it by the blood stream, the product formed and eliminated by the gland or organ is termed a *secretion*. In this sense the lungs, the skin and sweat glands in it, kidneys and rectum are excretory organs; the salivary glands, stomach, liver, pancreas and intestines are essentially secretory organs since they elaborate digestive juices whose active constituents are not present preformed in the blood.

The Lungs. Under normal conditions the lungs eliminate, by way of the exposed air, carbon dioxide conveyed to them by the circulating blood from all parts of the body. This carbon dioxide is formed in all tissues. The greater the activity of the organ, the greater is its production. During expiration the carbon dioxide content of the expired air is 4%. In diseased conditions the lungs may rid the body of volatile and toxic compounds, such as acetone, so that the room of a diabetic patient may have a "fruity" odor. Expired air is, furthermore, laden with water. An appreciable amount of water is eliminated from the body even during normal breathing.

The Skin. By virtue of the coiled sweat glands contained in the skin of man particularly, water and some preformed waste products and salts present in the circulation are eliminated through the pores of the skin. The total amount of such waste products is not very great. The loss of water, on the other hand, in a profuse sweat may be appreciable. The oily secretion, the *sebum* is a specific product of the sebaceous glands. All higher animals including man lose considerable water from the skin by a process of the sensible or insensible perspiration of the sweat

glands. A healthy man may lose thus as much as a quart of water per day (Newburgh and Wiley).

Kidneys. For all practical purposes the two kidneys are the chief organs of excretion. The total amount of water eliminated by them may be no higher or even less than that eliminated by the skin (1,200 cc.). However, the water as urine contains great quantities of organic and inorganic salts resulting from the digestion of food in the alimentary canal or from the further disintegration of the food products by the tissues. In addition, our protein foods are reduced eventually into products from which the body is incapable of deriving further energy or heat. These products, such as urea, uric acid, creatinine, etc., as *end products of protein and nucleoprotein metabolism* must be and are constantly eliminated by the kidneys if normal life is to continue. The urine, a concentrated watery solution of the body's waste products, is conducted from each kidney by a tube, the ureter, to the *urinary bladder*, which normally can be made to expel its contents from time to time to the exterior through the *urethra*.

Liver. The liver can be said to excrete and secrete the bile; for the bile is a great adjuvant for digestion of our food (particularly of the fat) by virtue of the specific salts of glycocholic and taurocholic acid which are formed by cells of the liver. As such, the bile is a *secretion* formed by the liver. However, the bile owes its characteristic brown, yellow, blue or green color to certain pigments which are definitely waste products derived in part from the hemoglobin or red coloring matter of the blood present in the erythrocytes or red blood corpuscles. In addition, the bile may contain mineral salts, organic substances, and drugs incorporated in the body. In fact, the liver may excrete selectively certain dyes into the biliary passages, which dyes when injected intravenously are not even eliminated by the kidneys.

Rectum. The last portion of the large intestine just above the anal opening is the rectum. The rectum contains for the most part the indigestible remnants of food from which most of the water has been absorbed until the material has normally the consistency of butter at room temperature. This material constitutes the *feces*. However, the large intestine actively secretes certain elements into the bowel and these salts of (lime, iron, magnesium, etc.) may be eliminated in higher concentration in the feces than in the urine. Other metallic salts and drugs used as medicaments may also be thus eliminated. One-fourth of the total fresh feces may consist of bacteria. The elimination of the feces constitutes the act of defecation which is usually initiated wilfully. Under certain conditions the act may take place quite involuntarily.

A. B. L.

EXECUTOR, one named in a *WILL* to execute the wishes of the testator. One can become an executor illegally, or *de son tort*, by running a dead man's business, collecting his debts, or generally speaking, interfering with the property. However, if a stranger should lock up the stable or unoccupied

house, collect money and give it to the widow, he does not become an executor.

EXEGESIS, or **EXEGETICS**, the science of the interpretation of the Bible, sometimes called exegetical theology or that branch of theology which treats of the exposition and interpretation of the Old and New Testaments. The word is derived from the Greek, meaning to guide out of or interpret. The method of exegesis involves, 1, the philology of the Bible, calling for an understanding of its original tongues, namely, Hebrew, Chaldee and Aramaic Greek; 2, the archaeology of the Bible, making requisite a knowledge of the social, political and religious influence of the various Biblical eras; 3, the Canon of the Bible, dealing with all questions relating to the selection of its various parts by the church and its general councils; and, 4, the criticism of the Bible, affecting textual variation, authorship, authenticity and the date of its various writings.

EXEQUATUR, a document authorizing a consular officer to exercise consular privileges in a particular place. It is issued by the territorial sovereign, formally recognizes the individual as consul, takes notice of the commission he holds from his own government and authorizes him to exercise his functions within the district of his appointment. The exequatur is always issued by the receiving government. An exequatur may be refused or revoked.

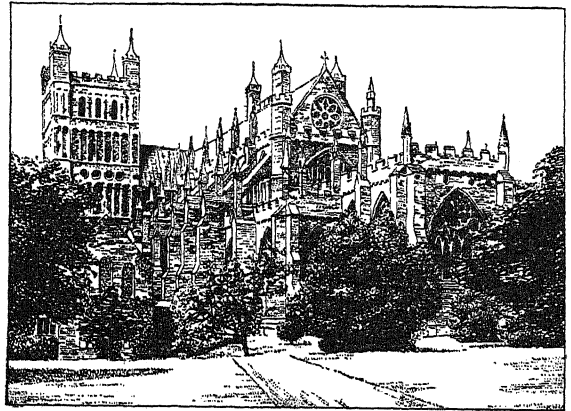
EXETER, a city and county town of Devonshire, England, lying upon a ridge above the Exe 172 mi. southwest of London. As the chief town of southwest England, the Roman *Isca Domnoniorum*, and the British *Caer Isce*, Exeter bore the brunt of Saxon, Danish and Norman sieges. The Roman city walls are well-preserved although all gates have disappeared, and the fragmentary Norman castle occupies British earthworks. Together with its cathedral, Exeter has numerous ancient churches, a picturesque Elizabethan guildhall, and many 18th and 19th century public buildings. There are pleasantly terraced early 19th century suburbs. Having a large trade in Elizabethan times, to-day Exeter, with a 5 mi. ship canal, (begun 1563), is still an important railroad and shipping center. Pop. 1921, 59,582; 1931, 66,039. See also **EXETER CATHEDRAL**.

EXETER, a town in southeastern New Hampshire, the county seat of Rockingham Co. It is situated on the Squamscott River, 50 mi. north of Boston, served by the Boston and Maine Railroad. Shoes and cotton goods are the chief manufactures. Garden and dairy products are the leading agricultural interests. Exeter is the seat of Phillips Exeter Academy for boys, established in 1781. The town was founded in 1638 and incorporated in 1639. Pop. 1920, 4,604; 1930, 4,872.

EXETER, a borough of Luzerne Co., northeastern Pennsylvania, situated 12 mi. southwest of Scranton. It is served by buses, trolleys and the Lehigh Valley and the Delaware, Lackawanna and Western railroads. The Wyoming Valley Airport is $\frac{3}{4}$ mi. distant. Coal mining is the outstanding industry of the vicinity. This region produces lumber and farm crops. Winter-

mooth and Scovill islands, in the Susquehanna River, are landscape features near Exeter. Pop. 1920, 4,176; 1930, 5,724.

EXETER CATHEDRAL, Exeter, England, one of the outstanding examples of the period of English Gothic architecture known as Geometrical Decorated. Though one of the smaller English cathedrals, it is among the most admirable. Except for the massive 12th-century towers of the transepts, it was built or rebuilt between 1280 and 1370. No English cathedral except Salisbury, which is bare by comparison, has such unity in interior design. Not only the struc-



EAST END OF THE CATHEDRAL, EXETER

tural whole, but the pillars, window traceries and even the tombs are balanced perfectly. Much of the satisfying beauty of the interior is due to the uninterrupted vista, with noble arcades and exquisite vaulting, made possible by the omission of the usual heavy piers at the crossing. An effect of lightness is created by the broad windows, which fill practically all the space between the buttresses. The plan, without central or western towers, is unique in England, and the church is purposely low, designed to emphasize breadth rather than height.

Exeter Cathedral has little sculptural decoration, but the episcopal throne, dating from 1308-26, in the choir, and the Minstrels' Gallery, built in 1400, on the north side of the nave are extremely interesting.

EXILARCH (Hebrew, *Rosh Golah*; Aramaic, *Resh Galutha*, meaning head of the Exile), the title given to the supreme head of Babylonian Jewry in the early centuries after the Exile when the Jews formed a large and important community there. The Babylonian Jews themselves were called *Golah* (Exile) ever since the year 586 B.C. The exilarchate was hereditary and entailed certain prerogatives. Its manner of origin and time of origin remain unknown. The exilarch was a descendant of the family of King David; according to tradition, the immediate descendant of King Jehoiachin of Judah, who was exiled to Babylonia, bore the title as early as the 6th century B.C. According to the Talmud, the title was held in the second half of the 2nd century A.D. There appear to have been exilarchs up to the middle

of the 11th century, and the title is found as late as the 12th and 13th centuries. The office of exilarch became extinct shortly after the first half of the 13th century. During the 9th to the 11th century there were exilarchs in Egypt as well, most of them members of the Babylonian dynasty.

In contrast to the Geonim (*see* GAON), who were the heads of the Jewish academies of Babylonia and the religious and spiritual heads of Babylonian Jewry, the exilarch was the political ruler of the Jewish communities of the country. After the year 642 he was responsible to the Mohammedan rulers, and his approval was required for the appointment of the Geonim. The exilarch had the power of collecting taxes from the Jewish communities for the maintenance of his court, which was often a luxurious and elaborate one. He had the power of excommunicating Jews who refused to obey his decrees, and acted as the supreme civil and political judge of the Jews.

The most important exilarchs were Huni Mari, who died as a martyr in 470 at the hands of the Persian King Peroz; Mar Zutra, who attempted to revolt against Persia and founded a small independent Jewish state, but was executed near Mahoza by the Persian general after a reign of seven years; Mar Zutra II, his son; Ahunai; Bostanai, who held office from 642 on, and was the first exilarch under Arab rule after the Arabs had conquered Persia in that year. Under Bostanai the political position of the exilarchate was rendered secure. A. SH.

BIBLIOGRAPHY.—S. Funk, *Revue des Études Juives*, 1884, pp. 121-25; *Die Juden in Babylonien*, 1902; Graetz, *History of the Jews*, 1926, under "Exilarch" and "Exilarchate" and index for the individual exilarchs.

EXILE, a word sometimes used to describe a prolonged absence for any reason, but in its most precise sense it means banishment by a sovereign authority. The Greeks used compulsory exile as a mode of punishment for certain crimes—many of them political (*see* OSTRACISM). Rome refined the Greek practice into three forms: *interdictio*, which amounted to exile because it prohibited the extension of either food or shelter to the condemned; *deportatio*, which sent the sentenced man to a specific spot; and *relegatio*, which denied the one on whom it was imposed the right to live in a particular locality. Deportation is recognized by the modern state and political exile is still common.

EXODUS, BOOK OF, commonly described as the Second Book of Moses, or the second section of the *Torah*, or Pentateuch, derives its name appropriately from its Greek title. It is logically connected with the preceding Book of GENESIS, and develops the chronicle of a family of 70 souls into the history of a nation so numerous that its Egyptian oppressors were alarmed. Its 40 chapters narrate history or folk tales, according to the point of view we adopt, which have become the heritage of three world religions. In it are found the stories of the plagues of Egypt, the crossing of the Red Sea, the wandering of the Israelites in the desert guided by a pillar of

cloud by day and of fire by night, the pronouncement of the Mosaic law on Mount Sinai, with its famous decalogue or TEN COMMANDMENTS, and the worship of the golden calf. It closes with the story of the manifestation of the divine presence in the tabernacle which the wanderers had constructed. Most modern scholars view the book as the much edited work of several writers from the 9th to the 7th century B.C., and consequently conceive its narratives as folklore rather than history. The older and more conservative views affirm that the essence of the book is Mosaic in authorship and that its stories belong to the early history of the Hebrew race, admitting that its miraculous elements may be subject in greater or less degree to rational explanations.

EXODUS, THE, in Biblical narrative the term applied to the departure of the Israelites from Egypt under the leadership of Moses. The details are recorded in Exodus 1-19. The historical account is based on the delivery of the oppressed Israelite or Hebrew serfs from Egypt. The route of the Hebrews lay along the Isthmus of Suez until they crossed the Red Sea and arrived in the vicinity of Mount Horeb, quite possibly in the neighborhood of Medina. Tradition has it that they wandered in the wilderness for 40 years, and Moses died before the Hebrews had made any conquests west of the Jordan. The period generally assigned to this migration is that of the Pharaoh Rameses II, at some time during the 13th century B.C.

EX-OFFICIO BOARDS. *See* BOARDS, ADMINISTRATIVE.

EXOGENY, the law among primitive peoples of marriage outside the group. This sometimes means the village, but usually denotes the large body of the family which makes up the clan, although clan membership and blood relationship do not invariably coincide. The origin of the rule of exogamy is uncertain. J. F. McLennan, who coined the term, traced the custom to the savage practice of female infanticide, with its resultant limitation of the number of women within the group, but little evidence is found to support this theory. Westermarck pointed out that under tribal social forms, natural horror of incest might well include all brothers and sisters of the clan, or dwellers together in the community. Lowie relates its development to rules of residence and of property. Although the severity of its enforcement varies, explorers have found exogamy a fairly widespread practice among native tribes but by no means universal.

EXOPHTHALMIC GOITER. *See* GOITER.

EXOPHTHALMOS. *See* EYE, AFFECTIONS OF: Malformations.

EXORCISM, the practice of casting out devils or curing of disease by ceremonies or rituals, especially of a religious nature. Exorcism has a long history, going back to the possession theory of disease and the priestly function of the medicine-man. Under Christian influence the formulae were elaborated, and even plagues of insects were dispelled by religious formula and excommunication. It continued as a form of mental healing (*see* FAITH CURE); thus a priest-healer

of the late 18th century would command the symptoms of weakness or chill to disappear, adding "in the name of Jesus" or of the trinity. Exorcism was practiced against the arts of the devil or of witches. When the demons were regarded as the source of disease, of what we now know as hysteria particularly, the process of casting out or dispelling them is clearly one of suggestion under the powerful reinforcement of religious prestige.

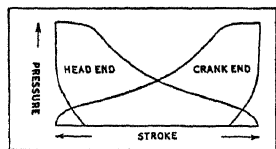
EXOTHERMIC REACTIONS, chemical reactions which precede with the evolution of heat to the surroundings. This will be manifested in general by a noticeable rise in temperature of the system. A rough parallelism is noted between the stability of chemical compounds and the amounts of heat liberated in the reactions by which they are formed from their elements. That this is far from an absolute criterion of stability however is seen in the fact that many stable compounds exist which are formed from the elements with more or less absorption of heat.

The temperature rise due to the heat evolved in an exothermic reaction may be sufficient to melt or even to vaporize some of the substances involved in the reaction. In the THERMIT WELDING process, the heat evolved in the reaction between powdered aluminum and iron oxide, $2\text{Al} + \text{Fe}_2\text{O}_3 = \text{Al}_2\text{O}_3 + 2\text{Fe} + 182,000 \text{ cal.}$, is sufficient to melt the iron formed, thus making it available for welding purposes. Other metallic elements, such as chromium, manganese, molybdenum, which are valuable in the formation of special alloys, may be recovered from their oxides by similar exothermic reactions with powdered aluminum; the products so obtained are of course free from admixture with carbon, the concomitant of the usual smelting operations. The high temperatures of the oxy-hydrogen and of the oxy-acetylene flames, employed for cutting metals, are also due to the heats of exothermic reactions.

L. O. C.

BIBLIOGRAPHY.—A. Findlay, *The Spirit of Chemistry*.

EXPANSION ENGINES, steam engines which make use of the internal energy, or expansion capacity, of the steam. Steam is admitted during a fraction of the piston's stroke, after which the valve closes the steam port and the steam, trapped in the cylinder, expands at a falling pressure and exerts force upon the moving piston. In this way the expansive energy of the steam is converted into mechanical power at the engine shaft. Practically all STEAM ENGINES are of this type.



INDICATOR DIAGRAMS, EXPANSION ENGINE CYLINDER

The length is proportional to the piston stroke and the height to the cylinder pressure

It has been found that for ordinary four valve engines the steam supply is best cut off at 20% of the piston stroke; single-valve engines at 25% and UNIFLOW ENGINES at 10%. The relation of steam pressure to piston stroke is illustrated in the figure. See also NON-EXPANSION ENGINES.

L. H. Mo.

EXPANSION JOINTS, flexible units inserted in pipe lines or between the turbine and condenser, or other parts of a power unit where large temperature differences exist, to allow linear expansion of the pipe with temperature changes. Four types of expansion joints in common use in steam lines are the corrugated, globe, non-collapsible copper, and cast-iron joints. The corrugated joint is essentially a section of corrugated copper pipe with flanges on each end for coupling. The globe joint is a section of copper pipe with a globe-like expanded circumference midway between the connecting flanges. The non-collapsible expansion joint is simply a flanged section of straight, heavy copper pipe which depends upon the elasticity of the copper for its expansive and contractive qualities. A standard type of cast-iron slip joint comprises a section of pipe into which the end of a smaller-diameter section fits and may slide in or out, the two sections being coupled by flanges and flange-bolts, and provided with gaskets to prevent the escape of steam. The double cast-iron joint comprises two sections fitted into a third, larger-diameter section. Sometimes this type of expansion joint is of complicated design, being provided with balancing sections on each end. A rubber expansion joint has recently come into use and is particularly adapted for low-pressure, low-temperature service, as in condenser applications. The first expansion joint used were loops or bends in the pipe line, which could flex and straighten out to accommodate the changes in pipe-line length. A recent adaptation of this principle comprises a U-shaped section of pipe with the inner side of the bend creased, or corrugated, to provide flexibility.

EXPECTATION OF LIFE. The laws of mortality can tell nothing with respect to the exact duration of life of any individual, since mortality tables refer to groups and not to individuals of the group. Expectation of life means the average number of years which individuals of a given age will survive. It is neither the most probable lifetime, nor does it disclose when the individual has an even chance of surviving. The expectation of life is found by adding the numbers living at all ages subsequent to the age for which the expectation is to be calculated, and dividing this sum by the number living at that age and adding one-half of .5. The one-half is added because each person besides completing a certain number of years may be expected to live a fraction of another year, some living a large fraction of the year and some a small fraction, so that, on the whole, all may be considered to live one-half the year. The chief value of expectation of life consists in using it to make an easy comparison of the death rates in different mortality tables. No actuarial calculations for financial purposes are based upon it. W. F. G.

In 1825 man's expectancy of life was 35 years. In the period of 100 years this expectancy has increased by 20 years, so that a child born to-day may reasonably expect to reach the age of 55. The life expectancy after reaching the age of 50 was, one hundred years ago, for 21 additional years; whereas to-

day the life expectancy after reaching 50 is for 21.2 years. If additional life expectancy is to be accomplished after middle age, it will have to come by overcoming the hazards of early heart disease, high blood pressure and other degenerative diseases. Such control must come through the periodic physical examination.

In the period from 1906 to 1921, there was an increase in expectation of life of about 14 per cent, the improvement being mostly in the earlier years of life. A child born in the United States has an expectancy at birth of 55.58 years if a male, and 57.73 years if a female. For England the figures are 55.62 for male and 59.58 for female.

A person does not inherit any particular tendency to longevity, but does inherit a type of body or constitution which enables him to survive better than does the average man. In 1,500 cases in which the age at death was known of both the individuals and of their parents, it was found that 5.3 per cent lived to the age of 80 when neither parent reached that; 9.8 lived to 80 when one parent reached that age, and 20.6 lived to 80 when both parents reached that age.

The figures indicate that expectation of life among wage earners in the United States in 1928 was 56.42 at birth, whereas in 1911 it was 46.63. Out of 3,000,000 deaths, in the experience of a great life insurance company, only 30 people were found to have reached one hundred years, of whom 20 were women and 10 were men.

M. F.

BIBLIOGRAPHY.—M. M. Dawson, *Practical Lessons in Actuarial Science*, Vol. 1.

EXPEDITIONARY FORCE, a military force sent outside the borders of its own country to execute a specific mission by force of arms. Good examples are the American Expeditionary Forces (A.E.F.), the name of the forces sent to France during the World War; the Punitive Expedition in Mexico in 1916; and the Mediterranean Expeditionary Forces (M.E.F.), applied to British forces in Salonika.

The necessity of marine expeditionary forces came from the fleet's growing in size, power, speed and radius of action, and the great distance necessary to be steamed to seek out the enemy fleet and engage it.

In 1912, the U.S. Navy Department assigned to the MARINE CORPS the task of organizing, equipping and drilling advanced base or expeditionary forces, embracing infantry, artillery, air forces, communication troops, engineers and the proper proportion of supply troops. Marine Corps plans call for an expeditionary force on the Atlantic Coast at Quantico, Va., and one on the Pacific Coast at San Diego, Cal. The Navy furnishes the required auxiliaries but transports of proper size are required.

EXPENDITURE, NATIONAL. See BUDGET, NATIONAL.

EXPERIMENTAL EDUCATION. This term is to-day used in two senses. Traditionally and currently the term is applied to any new scheme in education whether in administration, organization,

methods of instruction, or curriculum. During the past 25 years, however, there has developed a tendency to apply the term to experiments in education that can be scientifically tested. The objection that is raised to the first use of the term is that in this sense educational experiments have been based on the subjective opinions and beliefs, on philosophical speculations of the experimenter, which had no greater validity than the ability of the individual advocating or conducting the innovation to make out his case logically, and was no better subject to adequate proof than the practice or theory which it was attempted to displace. The contrast is made between the status of most sciences which up to the 17th or 18th century had been based on metaphysical speculations, and their progress since that time when they began to be based on experimental and verifiable data, subject to observation, objective measurements and testing.

Earliest Experiments. Experimental education in the first sense has always existed in so far as education has never for long been static and has changed with changes in educational theories, determined in part by philosophical criticism and in part by the recognized need of new adjustments to new social situations. The whole history of education can from this point of view be described as a history of educational experiments based on new interpretations of needs and on novel practices which attempted to give reality to them. Thus the type of education introduced in Greece by the sophists may be regarded as an experiment, as well as the first halting steps of early Christian education. The schools of Vittorino da Feltra and of the Brethren of the Common Life, the first modern schools of European civilization, were experiments undertaken as a protest against the formal and standardized practices of the mediaeval period.

The Reformation may be said to have introduced the earliest experiments in the elementary education of the masses. Subsequent educational theory devoted itself largely to the improvement of elementary schools, sometimes on the basis of a theory which came first, as in the case of the contributions of WOLFGANG RATKE and JOHN COMENIUS, who were largely influenced by Bacon's (see BACON, FRANCIS) contributions to scientific methods, or of JEAN JACQUES ROUSSEAU, or in the case of JOHANN HERBART and FRIEDRICH FROEBEL who dominated school practice through a large part of the 19th century but whose theories were derived speculatively and subjectively and later tested out; sometimes, as in the case of JOHANN HEINRICH PESTALOZZI, intuitive methods and observation; Bell and JOSEPH LANCASTER, monitorial system; Col. Parker, correlation; FRANK and CHARLES McMURRY, type studies and socialized recitation; Ziller and Rein, Herbartian method; Georg Kerschensteiner, methods of activity, and JOHN DEWEY, school and society, the experiments grew out of theory and practice.

In the field of secondary education the experiments grew out of a feeling of unrest with the formalism and traditionalism of established schools and a desire to introduce new elements responding more nearly

to new demands of changing society. In all these experiments and many others that might be cited the objection that is usually raised is that they were theoretical and speculative; that whatever changes may have been introduced were measured subjectively and not verified or tested scientifically. From another point of view the criticism is made with reference to the majority of the experiments that they were purely scholastic; that they were not thoroughgoing in the sense that they dealt with small reforms in method or content and did not investigate deeply the changes needed in the light of new social demands and new social theories, and that the fabric of the schools continued to remain as it was. In some instances the experiments were concerned with reform of the subject-matter content, in others with methods of instruction; elsewhere the reforms were administrative and dealt with plans of classifying and promoting pupils, and so on,—reforms based on theoretical considerations rather than comprehensive investigations of the needs of the child and of society, or, in other words, conducted from the adult point of view with a strong emphasis on mental discipline and the acquisition of knowledge.

Opposition to Formalism. The great era of experimentation in education has been the last 40 years. Beginning in those countries in which the administration of education was decentralized the movement has to-day spread throughout the world. Opposition to the formal conditions in organization, discipline and curriculum which disregarded the real interests of the pupils and the demands of changing modern society led to the establishment in England of Abbotsholme by Cecil Reddie, 1885, and of Bedales by J. H. Badley, 1893, which served as models for the *Landerziehungsheime*, or Country Educational Institutions, in Germany, first established by Hermann Lietz in 1898, and the *Ecole des Roches* and a few similar schools in France. In these schools efforts were made to go beyond the formal requirements of existing schools and to introduce manual and creative activities, open air life, coeducation in a few cases, and more natural relations between pupils and teachers. A beginning was here made to take into consideration the pupils' interests and to give a greater place to freedom. In Munich Kerschensteiner, experimenting with pupils in the continuation schools, endeavored to bring the activities of these schools into closer relationship with the real interests of the pupils and social-civic life, an experiment which constituted the basis of educational reforms in Germany and elsewhere to-day.

Broad Scope in United States. But it was essentially in the United States that the field of experimental education was most widely cultivated, partly because tradition on the whole has not played a great part in the life of the country, and partly because education is less subject to centralized bureaucratic control than elsewhere. Three important factors have here contributed to experimental education. The first has been the acceptance of a new psychology of the child. Influenced largely by the evolutionary theory,

metaphysical introspective psychology which analyzed mental functions has been replaced by the psychology of growth. Intensive study of the life of the child based on careful observation yielded a mass of data on the nature and development of child interests. The second factor, which came later and almost from the beginning of the present century, has been the development of experimental psychology and of the technique of tests and measurements and statistical determination, which furnished the bases for the development of scientific procedures in education. The third and perhaps the strongest influence has been the social and educational philosophy of John Dewey, with its emphasis on experience as the basis of growth and of learning, on the child's experience and activities, and on the theory that education is life and not a preparation for life. Dewey's philosophy of education has supplied the bases for critical evaluation of the traditional school as formal and stereotyped with an emphasis on the acquisition of standardized subject-matter and on the adult point of view, as essentially disciplinary and stressing drill, attention, memorization, textbook repetition, coercion and imposition from without. It has also supplied the fundamental principles of the new or progressive education, which, although not clearly defined, professes to emphasize the growth of personality through participation in activities and experiences pertinent to the life of the child, self-expression, a reconstruction of the curriculum and its content with the inclusion of fine arts, the cultivation of accurate thinking and critical judgment, and a close relationship between the school and environment. Inherent in all experiments derived from these principles is the social motive.

Experimental Schools. Here it is possible to mention only a few of the experimental schools which have sought reforms in the new direction: The laboratory school of the University of Missouri under Prof. J. L. Merriam; the Francis W. Parker School at Chicago and the School of Education of the University of Chicago; the City and Country Day School, the Ethical Culture School, the Walden School, and the Lincoln School of Teachers' College, Columbia University; the Park School, Baltimore; the Beaver Country Day School in Boston, and a host of others. A few experiments have been undertaken to demonstrate particular aspects of the reform, as for example, the experiment conducted in a Missouri rural school by Prof. Ellsworth Collings to demonstrate the effectiveness of purposeful activity. The project and the activity methods, which are outcomes of the new philosophy, have been put into practice not only in experimental schools as such but also in many public schools.

Other experiments have been undertaken, such as the Gary plan and its resultant, the platoon school plan, which seeks to utilize the school plant to its fullest extent; the Winnetka plan developed by Carleton Washburne as an experiment in the individualization of instruction; the Dalton plan, devised in its details by Helen Parkhurst for the individualization of learning on the basis of contractual assignments.

One result of experimental education has been to invigorate and reconstruct educational theory; it is changing the character of the school from a listening school to an activity school; it is leading in some respects to a transformation of school buildings and equipment; it is placing greater emphasis on education not as an imposition of adult-made information but as the cultivation of the personality of the child. In sum it seeks according to its advocates to shift the emphasis from the teacher and subject-matter school to the child-centered school. The most extensive activity in experimentation is found at the elementary level; the secondary schools while undergoing change have not been subject to such wholesale experimentation. On the other hand, there are a considerable number of experiments in college education as, for example, at Swarthmore, Antioch and Rollins colleges, and many others.

Important Movements in Europe. Experiments in education are characteristic to-day not only in the United States but in most of the leading countries of the world. Two large movements may be discerned, both based on somewhat the same principles as have already been indicated but differing in details of practice. The first of these, with which are associated the names of Olive Decroly of Belgium and Adolphe Ferrière, places its emphasis on community activities revolving around centers of interest, involving activity and methods of clear thinking on the part of the pupils. The other movement with which the new education in Germany, Russia and a number of central European countries is associated is that of the activity school, *Arbeitsschule*, *Arbeitsunterricht*, which, though less formal than the centers of interest, seeks to change the school from a listening, passive school, *Lernschule*, to an active, cooperative institution with less emphasis on dictation and the memorization of information and more on direct contact with the realities of life by direct appeal to the child's experiences and environment, expanded by means of excursions and in other ways, on the cultivation of the emotions as well as of the intellect, and on the development of personal methods of work and accurate thinking. Education everywhere is to-day being strongly influenced by the original experiments along these lines. On the extreme left attempts have been made, as in the *Gemeinschaftsschulen* of Hamburg, to conduct schools on the basis of Tolstoy's theory of an education based wholly on the immediate needs, demands and desires of the pupils.

Science of Education. Experimental education thus far described has been of the first type, that is, governed mainly by theoretical considerations influenced by contributions from social and political theory, from biology and physiology, and by the psychology of growth. The objection that is raised against such types of experimentation is either that the results cannot be measured until their effects are seen in the life of the pupils when mature, or that they are measured, if at all, subjectively. Hence there has developed, particularly in the United States and

to a much lesser extent elsewhere, a movement for objective, scientific experimentation in education, a movement to make the study of education as scientific, allowing for the differences in the content treated, as such sciences as physics and chemistry. In other words, the proponents of a science of education would emphasize the importance of controlled experiments, observation, collection of data, tests and measurements, and verification of data. In this sense G. STANLEY HALL and MARIA MONTESSORI may be described as pioneers so far as the utilization of scientific method is concerned, whatever the opinion of their conclusions may be.

Educational Psychology. More recently the chief contribution in this direction is being made through educational psychology, which seeks to limit itself to objective data derived from observation of and experimentation with the behavior or responses of individuals to stimuli or situations. The principle, as contrasted with the philosophical approach, is that psychology "observing responses, . . . endeavors to determine the situation which produced them; knowing the situations, it endeavors to predict the probable responses to them." (P. Sandiford, *Educational Psychology*.) Hence the educational experimenter can create a situation, vary it, use different control groups, measure the results, and arrive at conclusions that are verifiable and not mere opinion. Educational problems, in other words, can be solved only by quantitative methods. The techniques involved in this type of experimentation owe their development and refinement to such leaders as WILLIAM JAMES, Wilhelm Wundt, J. McKEEN CATTELL, Karl Pearson, C. E. Spearman, EDWARD L. THORNDIKE, CHARLES H. JUDD, LEWIS M. TERMAN, and others. Educational procedures can as a consequence now be based on the results of genuine scientific experimentation, the results of which are capable of statistical evaluation, on the theory that everything that exists exists in some amount and that amount can be measured. Educational advancement cannot accordingly be based on speculation or theory but must have a foundation in verifiable facts.

Experimental education from this point of view must be based on methods of observation, with or without experimental control; "the conditioned response method—the conditioning of reflexes, glandular secretions, and emotional responses;" the verbal report or responses to reactions obtained under experimental conditions; tests, chiefly of intelligence and achievement; and the interpretation of results by statistical techniques. Applying these criteria the educational psychologists have conducted extensive experiments in determining the nature and amount of intelligence, in deriving the laws of learning and its improvement, in discovering the extent to which there is any transfer of training or formal discipline, and in testing achievement in the regular school subjects: arithmetic, reading, spelling, algebra, geography, history, science, handwriting, etc. Laboratories, child clinics and actual school conditions have been em-

ployed in these inquiries. They have gone further and conducted analyses of the content of these subjects with a view to discarding what has been accumulated by tradition and retained for formal reasons and to discovering what aspects really function in life.

Another important contribution from this field of study has been the investigation of the traditional types of examination and through proof of their unreliability the suggestion of new objective types. Finally, as a result of these various experimental approaches to the curriculum and its content, the educational psychologist has contributed improved methods of teaching and learning, particularly in the skill subjects, especially reading, writing and arithmetic. Because these methods of experimentation and research appear to be more efficient than beliefs and opinions, they suited the quantitative character of the American mind and gained widespread approval. Similar methods and techniques have been devised in England, Germany and Austria, but they are employed with greater caution.

Philosophy of Education. The success of the objective scientific methods of investigation have encouraged their advocates to put forward the claim that experimental education based on unverified theories, that is, those experiments discussed in the earlier part of this article, is unsound, unscientific, and still subjective; that no educational method can be called sound until it has been subjected to scientific experimentation. This claim is contested by the philosophers and theorists of education who assert that, while many valuable contributions have been made by the scientific movement, it is in a position only to test what is already taught but is not able to define the aims and purposes of education or what should be taught in the schools. Educational psychology may define the nature and growth of the individual, may determine individual differences, may suggest improved methods of learning, may test the achievement; but the aims and purposes of education, what shall be learned, and the ends to be achieved can be defined only by a philosophy of education which, while it takes into account the contributions of educational psychology, must also consider the social, economic and political conditions of the group, community, or state in which education is to function. I. L. K.

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(2) On scientific experimentation in education: see the bibliographies in W. McCall, *How to Experiment in Education*,

1930; P. Sandiford, *Educational Psychology*, 1930; J. Dewey, *Progressive Education and the Science of Education*, 1928; T. L. Kelley, *Scientific Method, Its Function in Research and Education*, 1929.

EXPERIMENTAL PSYCHOLOGY. The tap roots of experimental psychology reach into physics, astronomy, physiology, biology, medicine and related sciences. (See **PSYCHOLOGY, HISTORY OF**). Although notable work had been done by experimentalists before this period, experimental psychology is ordinarily dated as beginning with the foundation of the first laboratory by Wundt in Leipzig in 1879. Wundt rendered two fundamental services; he assembled into his textbooks and journals a collection and interpretation of all previous experimental work, as gleaned from other sciences, under the general title of Physiological Psychology, and with this as a nucleus, he gave psychology a consciousness of itself as a possible science.

Phenomenal Development. A most phenomenal development has taken place since that date: first, in the opening up of new approaches and points of view in psychological measurement; second, in enrichment of the concept of mental life by the verification of new hypotheses and the accumulative amassing of experimental data; and third, in securing for the subject a place in the family of sciences. Wundt and his pupils began by reaction-time experiments, and for 20 years afterward intelligent men of science often asked if there was anything in psychology beside reaction experiments. When Wundt was asked what this experimental psychology had done for him, he replied that it had given him an entirely new insight into the nature of the human mind. The Wundtian psychology was structural and physiological and recognized a scientific place for introspection in the control of experiments. Structural psychology emphasized the analysis of mental processes into constituent factors, not on the assumption that these factors operate independently, but on the ground that when we are to explain any mental process, we must deal with one factor at a time. This principle still prevails in experimental psychology; but, in reaction to it, arose the so-called functional method which demanded that the experiment should be performed in the actual life situation and that the problem of experiment is not to analyze mental processes, but to discover how they function in their natural settings. This principle operated both as a valuable limitation and an enrichment of the scope of experiment. Further extension of the same principle came in through the field of animal study in which it was recognized that the observational method was unreliable and that introspection can play no rôle. Since the establishment of experimental psychology, the study of animal behavior has been completely revolutionized and studies in this field often set models for experiments on human beings. From this source came the beginnings of behaviorism, especially through the study of reflexes, under the primary leadership of Russian biologists, and is sometimes referred to as reflexology. (See

CONDITIONED REFLEX). Many of the principles of behaviorism have been observed in all experimental approaches to psychology from the beginning. The valuable contributions of the behaviorists have, however, been somewhat marred by a tendency to overreach. There are to-day almost as many attenuations of behaviorism as there are behaviorists in experimental psychology.

Clinical Psychology. A further reaction took the form of antagonism to structural psychology, erroneously criticized as atomistic. It carried the functional point of view one step further by stressing the fact that in every mental process the organism reacts as a whole and that a given mental situation must be explained in terms of its total background or setting. This point of view is called Gestalt, usually translated as configuration, psychology. Its emphasis upon this approach is a valuable contribution, although seldom contradictory to methods or findings from other approaches. It has enriched our insight into the relatedness of mental life. The same principle is exemplified in a quite independent movement of experimentation in clinical psychology and PSYCHIATRY, in which the program has stressed the ideal of regarding the total personality in the total situation. This together with the greatly varied psychiatric modes of experimentation, while largely restricted to the clinic, have greatly enriched the setting of psychological experiments. The laboratory experimenter has learned from the clinician countless significant factors in the control of normal behavior.

Then came the Freudian point of view, not experimental in the rigid sense of the word, yet of a serious character emphasizing the subconscious and unconscious mechanisms governing behavior. While the laboratory experimenter does not proceed by the method of the psychoanalyst, the findings in PSYCHOANALYSIS have placed countless new responsibilities upon the laboratory experimenter for the control and observation of the operation of these mechanisms in normal life. The point of view of spiritism, taboo in psychology proper, has nevertheless furnished problems on which reliable investigators have greatly enriched our insight into the operation of the human mind under experimental conditions; notably through such studies as those of AUTOMATISM, community of ideas, apparent thought transference, numerous forms of trance, DREAMS and HALLUCINATIONS.

At the close of the war, the mental test rage came near wrecking experimental psychology because it was so easy to proceed with paper and pencil without responsibility for scientific control demanded by the laboratory. But out of this movement have come some contributions to experimental psychology of a permanent nature largely through the extension of application of statistical methods to the treatment of data in group measurements.

There has been a general tendency for psychologists to reach out into the field of physiology, neurology, neuro-pathology, physical heredity, embryology, and related fields on the ground that psychology is

so dependent upon findings in these domains. These excursions have brought rich returns to the psychological laboratory. Thus in a brief period of 50 years, psychology has taken great strides and is taking a more and more comprehensive view of its problem. It is unnecessary to say that where there is no experiment, there is no scientific psychology, and wherever the psychologist enters with any justifiable confidence, he enters through the medium of experimentation. It is also true that where experiment is adequate, there is no place for schools in any science as experiment will ultimately lead to a common ground. While not a determinant in experimental method, experimental psychology is being greatly modified by changing philosophical conceptions as to the nature of mental life, conceptions based indeed in large part upon psychological studies resulting in the new conception of the nature of mind.

C. E. S.

See C. E. Seashore, *Elementary Experiments in Psychology*, 1908; C. A. Murchison, *The Foundations of Experimental Psychology*, 1929; E. G. Boring, *A History of Experimental Psychology*, 1929.

EXPLORATION, ELECTRICAL, in geophysics, a method of investigating geological formations by means of direct or alternating electrical currents. Due to their differing conductivities, rocks, soils, and ore-bodies have different effects on electrical and electromagnetic fields. See also GEOPHYSICS.

EXPLORATION, GEOPHYSICAL, the application of GEOPHYSICS to the study of hidden geological conditions, usually in connection with engineering structures, or for the purpose of locating valuable mineral deposits.

EXPLORATION, GRAVIMETRIC, called also gravitational or gravity survey, a method of geophysical exploration in which the earth's gravitational field is studied in order to gain geological information. If this field is slightly weaker, or stronger, than normal, it indicates the presence in that vicinity of geological formations of lighter, or heavier, specific gravity than their surroundings. See also GEOPHYSICS.

EXPLORATION, MAGNETOMETRIC, or magnetic survey, a geophysical method of exploration in which the direction and intensity of the earth's magnetic field are measured. A mass of ore, rock, or other geological formation, which exerts a stronger repellent or attractive, effect than the surrounding material on lines of magnetic force, can be detected. See also GEOPHYSICS; MAGNETISM.

EXPLORATION, MINE. See MINE EXPLORATION.

EXPLORATION, SEISMIC, or "earth-wave survey," in geophysical exploration a method of investigating concealed geological formations by observing the refraction, reflection, and retardation or acceleration they produce in transmitting artificial earth tremors. Small earthquakes are produced by exploding charges of dynamite, and the times of arrival of the resulting waves are then noted at a number of portable seismograph stations. See GEOPHYSICS; SEISMOGRAPH; SEISMOLOGY.

EXPLORER. The occupation of explorer, though probably the least crowded of all the modern occupations, can hardly be said to be either a profession or a business. It is attended with hardships and dangers, and must be conducted as the opportunity offers. Exploration is usually dependent entirely upon whether the explorer has sufficient means to carry out his plans, or can raise money by appeals to his friends and scientific organizations. It can occupy only a small portion of a man's life because of these limitations. Even Amundsen, the most indefatigable of modern explorers, had long periods of inactivity and disappointment between his remarkable expeditions.

The modern explorer should have a definite scientific objective. Frequently he is a scientist, though commerce and business are to some extent still companions in exploration. It was with the ostensible purpose of seeking knowledge as to airplane routes that recent explorations were made in Greenland. Expeditions which have done much valuable exploration in the Antarctic have obtained financial help because they could also look for new whaling grounds. However, few men have done their work with more self-discipline or unselfishness than the explorer.

R. O.

EXPLOSIONS, DUST. All dusts of readily combustible solids are explosive. The explosive quality increases with the percentage of volatile combustible matter present. Some coals with resinous inclusions are especially dangerous. From 50 to 75% of inert rock dust is needed to make bituminous coal dust non-explosive. See also DUST IN MINES; VENTILATION, MINE.

EXPLOSIVES, the total number of explosives is very large, but those of importance are few. Nitroglycerin is alone used in blasting oil wells; dynamite, gelatine dynamite and black blasting powder in blasting; black GUN POWDER to a slight extent in fireworks and firearms; smokeless powder or colloided NITROCELLULOSE, with or without nitroglycerine, in modern cannon and firearms; mercury fulminate, tetryl, picric acid and lead Azide in blasting caps; mercury fulminate in percussion caps: T.N.T. or trinitrotoluene, with or without ammonium nitrate, picric acid and ammonium picrate, as shell bursting charges. Liquid oxygen absorbed in special carbon has some of the same uses as a dynamite.

NITROGLYCERINE cannot be shipped by rail. What little is used as such is made near the point of consumption. Of DYNAMITE, about 350,000,000 pounds is used every year in the United States in blasting coal and ores, in quarrying, earth and rock construction, stump removal and drainage. *Black blasting powder* contains sodium nitrate instead of potassium nitrate. It is not used as much as formerly, because of its danger of igniting gas and dust in mines. It is made in grains varying from fine powder to the size of marbles, to vary the speed of burning. It does not detonate, but burns rapidly, giving off much smoke and poisonous carbon monoxide. It is also pressed into cartridge form. SMOKELESS POWDER is used in

all modern firearms and cannon, many varieties being made for different guns. MERCURY FULMINATE is a heavy gray powder produced by dissolving mercury in nitric acid, adding alcohol, and washing. It is stored under water, being extremely sensitive to shock, and is dried in small lots. Mixed with potassium chlorate, it is compressed into copper shells to form blasting caps, which are used to detonate other explosives. LEAD AZIDE or lead nitride, is made by mixing a soluble lead salt solution with sodium Azide solution, has properties like mercury fulminate, but less is required for the same purpose. *Tetryl* (trinitrophenylmethylnitramine), is used in shell as a booster charge between detonator and insensitive main charge, and as the base charge in blasting caps beneath fulminate or azide. PICRIC ACID (trinitrophenol) made by nitrating PHENOL (carbolic acid), melts at 122° C. and has an intensely bitter taste. It is used as the base charge in blasting caps and as a shell bursting charge. TRINITROTOLUENE, or T.N.T., is prepared by nitrating TOLUOL in three stages, is a pale yellow substance melting at 82° C., usually cast into shell for the bursting charge. It is used in cordeau, a lead fuse that detonates at high velocity, and is used for the simultaneous detonation of a number of boreholes. *Amatol* is a mixture of ammonium nitrate and trinitrotoluene. While hot it is pressed into large shells as a bursting charge. It is insensitive, and requires a large "booster" to force its detonation. *Ammonium picrate* is the ammonium salt of picric acid. It is used in shells as the bursting charge. *Nitrostarch* is used in some dynamites. Gun cotton itself is not used as an explosive.

E. M. Sy.

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EXPONENT, in mathematics, a number which, in its original use, showed the number of times a given number, called the base, was taken as a factor; that is $2^3 = 8$, 2 being the base, 3 being the exponent, and 8 being the third power of 2. In modern mathematics, in the expression a^x , a and x may be any kinds of number so long as the laws for positive integral exponents remain constant, that is, that $a^m a^n = a^{m+n}$, $a^m : a^n = a^{m-n}$ and $(a^m)^n = a^{mn}$. To meet these laws we define as follows:

$$a^{-m} = 1/a^m, a^{\frac{1}{2}} = \sqrt{a}, a^{\frac{3}{2}} = \sqrt[3]{a^2} \text{ and } a^0 = 1.$$

As shown in Euler's formula, $e^{\pi i} = -1$, so that a transcendental number (here e) to a power which is the product of a transcendental number (π) and the imaginary unit ($i = \sqrt{-1}$), may be a negative real number (-1). See EULER'S FORMULA; COMPLEX NUMBERS; TRANSCENDENTAL NUMBERS.

EXPORT OF CAPITAL. See CAPITAL, EXPORT OF.

EXPORT POINT. See GOLD POINT.

EXPORTS, INVISIBLE, see INTERNATIONAL PAYMENTS.

EXPORTS AND IMPORTS, terms commonly used to designate the movement of merchandise from

EXPORTS AND IMPORTS

one country to another. They do not include the purchase and sale of property rights such as securities nor such intangible items as electric power and services. GOLD and sometimes SILVER are likewise excluded.

International commerce is largely a creation of the 19th century. The best estimates indicate that from 1800 to the outbreak of the World War the value of world trade grew from less than \$1,500,000,000 to about \$20,000,000,000. The per capita trade increased about six times.

The war also gave an unprecedented opportunity to non-European nations to expand their trade. The result is that Europe is playing a much less important part in world commerce today than it did before the war. During the years 1911 to 1913 Europe contributed 60% of world exports. In 1929 its share had fallen to 49%. Europe's loss has been absorbed chiefly by North America and Asia, particularly by the United States, Canada, and Japan. The following table gives the exports and imports in 1929 and 1930 of the nations of the world.

WORLD TRADE—EXPORTS AND IMPORTS

1929 and 1930—82 Countries

(In Millions and Tenths of Millions)	Exports		Imports	
	1929	1930	1929	1930
Total, 82 Countries.	\$31,983.1	\$25,480.9	\$34,673.0	\$28,038.9
North America (11 countries)	7,150.8	5,270.5	6,234.0	4,502.1
South America (11 countries)	2,085.0	1,347.2	1,793.4	1,282.9
Europe (29 countries)	16,166.2	13,873.2	19,830.8	16,964.9
Asia (14)	4,660.1	3,512.3	4,530.7	3,468.8
Oceania (2)	864.8	660.7	943.6	659.7
Africa (15)	1,056.2	817.0	1,340.5	1,160.5
United States	5,241.0	3,843.2	4,399.4	3,060.9
Canada	1,208.3	905.4	1,299.0	1,008.5
Newfoundland	36.8	40.0	29.2	31.9
Mexico	248.6	216.2	184.5	165.0
British Honduras	4.9	4.5	5.1	4.9
Costa Rica	18.2	16.3	20.2	10.8
Guatemala	24.9	23.6	30.4	16.5
Honduras	24.6	26.2	14.9	15.9
Salvador	18.4	13.6	17.9	12.4
Cuba	272.4	167.4	216.2	162.5
Haiti	16.7	14.1	17.2	12.8
Argentina	907.3	512.8	820.1	617.3
Bolivia	50.8	36.9	25.9	21.1
Brazil	455.9	311.4	416.6	251.0
Chile	276.6	160.4	195.1	168.8
Colombia	122.5	108.8	122.0	60.6
Ecuador	17.2	16.1	17.0	12.8
British Guiana	12.4	10.8	10.8	9.6
Dutch Guiana	4.0	3.4	3.4	3.7
Paraguay	12.8	11.8	13.2	12.6
Peru	134.0	88.2	75.9	48.7
Uruguay	91.5	86.6	93.4	76.7
Albania	2.8	2.4	7.5	6.4
Austria	307.9	261.0	459.0	379.2
Belgium	883.2	729.7	984.6	859.6
Bulgaria	46.2	44.6	60.1	33.1
Cyprus	8.0	5.9	9.7	6.9
Czechoslovakia	606.8	517.2	519.6	465.1
Denmark	458.8	431.6	480.7	462.8
Estonia	31.2	25.8	33.3	26.4

(In Millions and Tenths of Millions)	Exports		Imports	
	1929	1930	1929	1930
Finland	\$ 162.0	\$ 136.0	\$ 136.4	\$ 132.2
France	1,965.5	1,678.9	2,282.2	2,051.9
Germany	3,210.2	2,870.5	3,201.7	2,478.8
Greece	90.1	76.9	171.3	141.1
Hungary	181.6	159.2	186.0	145.7
Irish Free State	233.0	222.6	298.3	276.1
Italy	801.4	637.3	1,139.6	911.3
Latvia	52.9	47.8	69.9	57.2
Lithuania	33.0	33.4	30.6	31.2
Malta	2.8	2.3	19.7	18.7
Netherlands	799.8	691.0	1,106.4	972.1
Norway	201.5	183.2	287.5	286.0
Poland	315.7	273.0	349.1	252.0
Portugal	48.0	42.4	113.0	108.0
Rumania	172.5	169.7	175.2	134.1
Spain	406.9	443.8	528.2	472.3
Sweden	485.7	415.4	477.7	445.9
Switzerland	400.7	337.0	515.8	487.5
U. S. S. R. (Russia)	475.7	533.7	453.5	545.3
United Kingdom	4,083.2	3,199.9	5,940.9	5,084.7
Yugoslavia	139.4	120.0	133.7	123.2
British India	1,190.6	927.3	900.0	666.5
Ceylon	154.2	115.0	147.1	110.3
British Malaya	518.6	369.6	497.8	399.6
China	660.0	420.1	820.0	611.0
Chosen	159.4	131.6	195.0	181.3
Iraq	20.6	15.2	36.6	27.6
Japan	990.5	726.0	1,021.7	763.6
Netherland East Indies	581.4	483.6	431.0	335.1
Palestine	8.5	10.1	34.9	34.0
Philippines	164.4	133.2	147.2	123.1
Siam	101.9	80.3	89.1	75.3
Syria	20.0	17.8	57.2	49.8
Taiwan (Formosa)	15.3	11.3	29.8	22.3
Turkey	74.7	71.2	123.3	69.3
Australia	600.0	444.9	706.5	452.1
New Zealand	264.8	215.8	237.1	207.6
Algeria	152.0	178.4	229.6	228.5
Egypt	268.5	164.3	280.9	237.0
Gambia	4.1	4.4	2.9	2.6
Gold Coast	56.6	43.2	46.8	38.9
Kenya-Uganda	34.2	26.7	38.2	30.3
Morocco (French)	48.3	27.9	100.0	86.6
Nigeria	86.4	72.9	64.3	59.0
Nyasaland	3.0	3.4	3.6	3.6
Southern Rhodesia	29.9	24.8	41.8	35.7
Sierra Leone	7.3	5.8	8.1	6.5
Sudan	34.0	26.2	34.2	30.8
Tanganyika	19.4	14.1	20.9	19.4
Tunisia	55.2	44.2	77.8	82.6
Union of South Africa	249.6	174.2	384.7	292.9
Zanzibar	7.7	6.5	6.7	6.1

The rise of the United States as a commercial nation can be seen from the following table.

EXPORTS AND IMPORTS OF THE UNITED STATES

(In millions of dollars)

Year or Yearly Ave.	Exports	Imports
1801-1810	\$ 75	\$ 93
1851-1860	249	284
1901-1910	1,617	1,159
1911-1915	2,371	1,712
1921-1925	4,397	3,450
1926-1930	4,777	4,034
1930	3,843	3,061

Source: Statistical Abstract of the United States.

The increase prior to the 20th century, important as it was, pales into insignificance compared with the later increase. It should be noted, however, that a considerable portion of the growth after 1914 was due to the increase in unit prices. We find that as measured by physical volume exports in 1930 were only 30% more than in 1913 while imports were 76% more.

In spite of its rapid increase, the foreign trade of the United States is growing no more rapidly than is the production of goods. It exports only about 10% of the domestic output of movable goods. The per capita trade is also small, only about \$75 in 1929 as compared with \$218 for Great Britain and \$269 for Canada.

Both exports and imports of the United States consist of a large number of individual commodities. In the export trade only three articles amounted in 1930 to 10% of total exports while no article amounted to 10% of total imports. The following tables give the values of the chief articles exported and imported in 1930 as well as the annual average for the period 1922 to 1926.

EXPORTS OF LEADING COMMODITIES FROM THE UNITED STATES

(In millions of dollars)

<i>Commodity</i>	Average 1922-1926	1930
Machinery	\$318.6	\$520.6
Raw cotton	861.0	496.7
Petroleum products	436.0	494.2
Automobiles	224.5	277.4
Wheat and flour	268.7	157.5
Meat products and lard	274.2	153.5
Raw tobacco	151.0	145.6
Iron and steel products	221.1	201.8
Chemical products	112.8	128.0
Fruits and nuts	91.2	110.9
Copper	138.4	105.3
Coal and coke	137.7	89.8
Cotton mfg.	135.7	88.7
Wood products	126.9	108.2
Rubber and mfg.	45.0	58.9

Commerce Reports, Feb. 23, 1931.

IMPORTS OF LEADING COMMODITIES IN THE UNITED STATES

(In millions of dollars)

<i>Commodity</i>	Average 1922-1926	1930
Raw silk	\$374.9	\$262.9
Coffee	241.8	209.5
Paper and mfg.	115.5	147.4
Petroleum products	100.2	145.1
Crude rubber	279.3	140.6
Sugar	294.8	129.6
Chemical products	122.9	112.1
Paper base stocks	106.7	106.9
Copper	88.6	104.6
Hides and skins	98.9	92.3
Fruits and nuts	78.3	75.1
Vegetable oils and fats	67.5	73.4
Furs and mfg.	96.4	68.7
Art works	37.7	65.2
Tin	74.2	60.2
Oilseeds	59.6	54.9
Burlaps	68.6	54.3

Commerce Reports, Feb. 23, 1931.

A significant development in the foreign trade of the United States has been a profound change in the economic nature of the articles exported. Raw materials and foodstuffs have been steadily declining in importance while manufactured articles have been steadily increasing. For the period 1910 to 1914 raw materials composed 33.5% of total exports. In 1930 they composed only 21.9%. Foodstuffs formed 19.7% of exports in the earlier period, but only 14.3% in 1930. Finished and partly finished manufactures, on the other hand, constituted 46.7% in 1910-1914 but 63.8% in 1930. This means, of course, that it does not have so great an exportation of agricultural commodities as formerly. Prior to the World War almost exactly half of the exports were of agricultural commodities. Factory products constituted only one-third. At the present time agricultural products constitute only about one-third while factory products constitute one-half.

The import trade shows few changes. In 1930 they were divided as follows: crude materials, 32.7%, foodstuffs 22.7%, and manufactures 44.6%.

The foreign trade of the United States is widely diffused geographically and is continually becoming more so. During the 19th century its trade was carried on almost exclusively with Europe. Even as late as the decade of the nineties Europe absorbed three-fourths of the exports and contributed over one-half of the imports.

So far as individual countries are concerned, Canada and the United Kingdom are by far the most important in both exports and imports. The former received 17.2% of the United States exports and sent 13.1% of its imports. The United Kingdom received 17.6% of exports and sent 6.9% of imports. The following table shows exports and imports with leading countries.

DISTRIBUTION OF THE FOREIGN TRADE OF THE UNITED STATES BY NATIONS IN 1930

(In millions of dollars)

<i>Country</i>	<i>Exports</i>	<i>Imports</i>
Canada	\$659.3	\$402.3
United Kingdom	678.1	210.0
Japan	164.7	279.1
Germany	278.2	177.0
France	224.0	113.8
China	112.8	113.3
Cuba	93.6	122.0
Argentina	129.8	71.9
Brazil	53.8	130.9
Italy	100.4	79.3
Philippine Islands	64.9	109.4
Mexico	116.2	80.3
British Malaya	9.6	144.0
Netherlands	104.9	51.2
British India	45.2	104.1

U. S. Dept. of Commerce, Foreign Trade of the United States in 1930.

A. F. L.

BIBLIOGRAPHY.—U. S. Bureau of Foreign and Domestic Commerce, *Commerce Yearbook*.

EXPORT TAX, a tax levied on goods exported from a country, usually at the point of departure. In

the United States export tax is prohibited by a clause in the Constitution.

EXPOSITION. See WORLD FAIRS.

EX POST FACTO LAWS. The Supreme Court of the United States (in *Calder vs. Bull*) defined ex post facto laws to include "every law that makes an action done before the passing of the law, and which was innocent when done, criminal, and punishes such action; every law that aggravates a crime or makes it greater than it was, when committed; every law that changes the punishment, and inflicts a greater punishment than the law annexed to a crime when committed; and every law that alters the legal rules of evidence and requires less, or different testimony than the law required at the time of the commission of the offense, in order to convict the offender." Although not all retroactive legislation has been forbidden by the Constitution of the United States, Section 9 of Article I is exceedingly explicit in regard to ex post facto laws. "No bill of attainder or ex post facto law shall be passed." S. C. W.

BIBLIOGRAPHY.—W. B. Munro, *The Government of the United States*, 1919.

EXPOSURE METER. See ACTINOMETER.

EXPRESSION, MUSICAL. See MUSICAL EXPRESSION.

EXPRESSIONISM, a movement in art in the first decade of the 20th century. It also affected literature and to some extent, music. Led chiefly by Russians and Germans, Expressionism in art has been defined by Paul Colin as "based on the expression of objects, an expression sought in the brain or heart of the artist and realized by distortion." In pursuit of their ends the artists used any and all means, even to the application of newspaper clippings, buttons, bits of tin and the like to their canvases. Chagall, Marc, Kokoschka were among the artists associated with the movement.

BIBLIOGRAPHY.—Paul Colin in *l'Amour de l'art*, 1920; Bahr, *Expressionism*, 1925.

EXTRATERRITORIALITY. See EXTRATERRITORIALITY.

EXTORTION, oppression under pretence of right, particularly exaction of money by an officer under color of his office when none is due, or when less is due than that exacted. It is a misdemeanor at common law and is generally provided for also by statute.

EXTRACTS, a term which applied to flavoring agents, with the exception of salt and meat extracts, are generally solutions in ethyl alcohol of the odorous parts of the leaf, stem, root, flower or fruit of plants. They are used for flavoring foods, beverages, medicinals and perfumes. While extracts have no actual food value, their pleasing taste and aroma so stimulate and aid digestive processes that they are considered an increasingly important food adjunct. Flavoring extracts actually appeal through their aroma rather than through their taste, as the tongue distinguishes only salty, sweet, sour and bitter.

Vanilla is by far the most popular extract and is

used in perfumes and for flavoring cookery, confectionery, ice cream and beverages. The extract is made from vanilla beans, alcohol, pure water, with glycerine and sugar generally added. The beans are chopped, their flavor absorbed in the alcoholic solution by maceration or percolation, and the resulting liquid aged in great oaken vats. Flavoring extracts are made with alcohol as the solvent, as it is the best material for this purpose, and as the flavoring constituents impart their flavor most satisfactorily when in solution. The volatile alcohol is essentially driven out by heat and exposure when extracts are added to food, and only the flavor and aroma remain.

Lemon and orange are made from extracting oil from the rind and dissolving it in alcohol. These flavors are used extensively in cookery, confectionery and beverages. Almond extract is obtained by pressing, powdering and drying bitter almonds. After fermentation and distillation, the oil obtained is dissolved in alcohol and diluted with water. True flower extracts, such as rose extract, are made from a base of oil. This is obtained by putting water on the flower petals, distilling them repeatedly, and separating the oil from the distillate. It takes one and one-half tons of rose petals to make one pound of oil; and attar of roses costs about \$10 an ounce. Many flower perfumes are not true extracts, but are made synthetically. Most violet extracts, for instance, are made from orris root, with the addition of a derivative chemically similar to the aromatic principle of the flowers.

Pure fruit extracts, such as raspberry, strawberry, cherry and pineapple, are obtained by concentrating the flavoring from the fruit, usually by means of a vacuum still, at a low temperature. Imitation extracts are compounded from esters, aldehydes, higher alcohols and other flavoring materials. These products are being constantly improved, as a result of research in this field. Fruit extracts are used largely in beverages and confectionery.

The flavors of spices such as clove buds, cinnamon and cassia bark, ginger root and nutmeg seeds, are extracted by percolating the ground spice with alcohol or dissolving the essential oil. Spices were the first flavorings known. Peppermint, wintergreen and spearmint oils are distilled from dried plants of the same name. These are used in medicinals, and for flavoring confectionery and chewing gum. Onion extract, concentrated from the vegetable, is used in flavoring soups, meats and salads. B. H. S.

BIBLIOGRAPHY.—Livermore & Knight, *The Story of Vanilla*, 1926.

EXTRADITION, according to the United States Supreme Court is "the surrender by one nation to another of an individual accused or convicted of an offense outside its own territory and within the territorial jurisdiction of the other, which, being competent to try and punish him, demands surrender." In some of the continental states such as Italy, crime is regarded as a national act, and is punishable by the laws of the state of the accused. In England and the United

States crime is regarded as a territorial act. In the United States extradition is a national and not a state act except between states of the Union. The extradition of criminals is not a matter of international obligation and is generally regulated by treaty. Treaties of extradition do not confer an absolute right of demand and surrender, but contain detailed regulations as regards evidence and the procedure of surrender. A person may be surrendered only for a treaty offense and only for the one for which he was extradited.

EXTRAPOLATION, the calculation of values of a function known for certain intervals of values of the variables for values of variables lying outside of those intervals. For instance, the calculation of the death rate of the population of United States in 1940 from the known rates in 1890-1930. See INTERPOLATION.

EXTRATERRITORIALITY, a term which signifies an exemption from the operation of local law. It has been applied by states of European civilization to their citizens in countries of non-European civilization, largely in the East, due to the diversities in customs, laws and institutions. The right of extraterritorial jurisdiction in the Far East has always rested on express treaty agreement, and its exercise is regulated by positive legislation on the part of the country enjoying the privileges. The jurisdiction is exercised in the main by the diplomatic and consular officers of treaty powers. Extraterritoriality in Turkey has rested on custom and on CAPITULATIONS as well as on modern treaties. Turkey renounced extraterritoriality, and this renunciation was confirmed by the Treaty of Lausanne. China is repeatedly demanding the abolition of the practice. C. E. MA.

EXTRUDING OF METALS, a process of pressing metals through DIES. Nearly all metals can be made to flow plastically if sufficient pressure be applied and if sufficiently strong and hard materials can be secured for the dies through which the metal must flow. Lead pipe and lead-pipe turns, such as elbows and S shapes for plumbers' traps, have been extruded for years, by forcing heat-softened lead through an annular orifice. Bends, either straight or reverse, are secured by feeding a little more metal into one side of the opening, this extra metal forcing the pipe to bend as it is being formed. Brass and copper are now extruded in large quantities, the dies being so shaped as to give the desired section to the metal as it is forced through them.

While extrusion of cold metal is possible in some cases, it is usually more desirable to heat the metal sufficiently so that it will flow with less pressure and less disturbance of its molecular structure. The question of getting dies to stand the pressure and the wear is the limiting factor. It would probably be possible to extrude steels if a material could be found which would stand the pressure and stresses imposed. At present the brasses are about the hardest metals which can be commercially extruded. F. H. C.

EYCK, VAN, HUBERT (c. 1366-1426), Flemish artist, elder of two brothers distinguished in the his-

tory of painting, was born at Maaseyck, Flanders, about 1366. He and his brother, Jan, are considered the founders of the Flemish school and are noted for their working out of a successful medium for oil-painting. Their joint masterpiece in painting is the renowned altar-piece in the church of St. Bavo at Ghent, *The Adoration of the Lamb*, an elaborate triptych with many panels. The landscape is as noteworthy as the multitudinous figures. The work was begun by Hubert and completed by Jan, but it is difficult to determine what portion was executed by each. Hubert died at Ghent Sept. 18, 1426.

Jan van Eyck (c. 1385-1441), pupil and associate of his elder brother, was also born at Maaseyck. His share in the great triptych is not his only claim to fame. After the death of his brother he became court painter to Philip the Good of Burgundy and his success in portraiture was such that he has been called "the greatest of all time." Among his masterpieces are a portrait of his father-in-law in the National Gallery, London, familiarly known as *The Man with the Turban*, and the well-known portrait of *Jan Arnolfini and his Wife*. Jan died at Bruges, July 9, 1441.

EYE, the organ of vision, is essentially a globe, transparent in front, and containing there a lens so placed as to cause rays of light which strike it to converge to an image on the back wall.

The wall of the organ is composed of three coats (see accompanying figure). The outermost coat is the sclerotic or sclera (*Sc.*). It is the thickest of the layers, and is composed of connective tissue fibers between which are few vessels. In front it merges into the cornea (*Cor.*) which is a segment of a smaller sphere than the sclera. It occupies the front sixth of the eyeball. Though the sclera is white and opaque, the cornea is perfectly transparent. The choroid coat (*Ch.*) lies internal to the sclera. It is thin and of a deep chocolate color. The vessels and nerves supplying the eyeball lie between the two coats. The ciliary arteries (*C.A.*) pierce the sclera near to the entrance of the optic nerve (*O.N.*). The ciliary nerves derived from the fifth cranial nerve enter the space a little further out. The arteries and nerves together run toward the front of the eye. The veins, *venae vorticosae* (*V.V.*), four in number, enter the vascular tunic at some distance from the meridian.

The most internal of the layers is the retina. This is the layer sensitive to light. It is composed of a number of secondary layers occupied by the rods and cones which actually perceive light, together with several strata of nerve cells and their processes which conduct the stimuli to the optic nerve. The outermost layer of the retina, next to the choroid, is filled with rhodopsin or visual purple, a pigment important in vision. The innermost layer, next to the cavity, is composed of the radiating fibers of the optic nerve.

The lens (*L.*) is suspended by an enveloping membrane, the suspensory ligament (*S.L.*), whose margin is attached by its circumference to the rim of the deep cup formed by the choroid layer. This rim is thick-

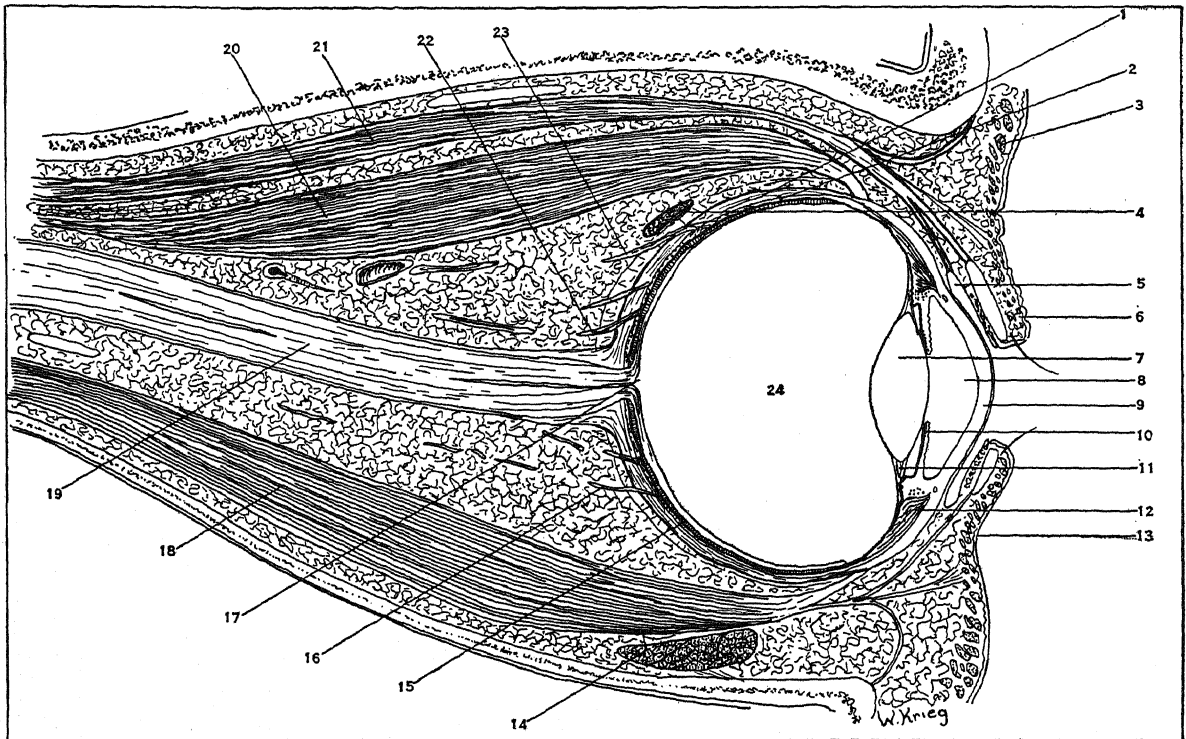
ened and thrown into radial folds, and is known as the ciliary body (*C.B.*). Contained in it is the ciliary muscle, which by tightening or relaxing the suspensory ligament causes the lens to flatten or bulge. The iris (*Ir.*) the brightly colored part of the eye, is an annular diaphragm attached by its circumference to the ciliary body. It contains concentrically arranged muscle fibers which contract its aperture, the pupil, and radially arranged fibers which dilate it.

The cavity between the cornea and the lens is the anterior chamber (*A.C.*). It contains a clear watery fluid, the aqueous humor. The cavity of the bulb, or

penetrates the sclera and choroid, to be distributed to the retina.

The front of the cornea is covered by a thin membrane, the conjunctival sac (*C.S.*). This layer is continued over the back of the eye lids, forming the conjunctival sac. The upper lid (*U.L.*) is raised by a long muscle lying over the superior rectus muscle, the levator palpebrae superioris (*L.P.*). The orbicularis muscle of the eye (*O.O.*), whose fibers are arranged in a ring, closes the lids.

The space in the upper and outer part of the orbit unoccupied by muscles contains the lachrymal gland



THE HUMAN EYE AND ITS ORBIT (IN SECTION)

1 Sc., sclera; 2 Ch., choroid layer; 3 O.O., orbicularis muscle; 4 S.O., superior oblique muscle; 5 C.S., conjunctival sac; 6 U.L., upper lid; 7 L., lens; 8 A.C., anterior chamber; 9 Cor., cornea; 10 Ir., iris; 11 S.L., suspensory ligament of lens; 12 C.B., ciliary body; 13 O.O., orbicularis muscle; 14 I.O., inferior oblique muscle; 15 Ret., retina; 16 C.N., ciliary nerve; 17 Fo., fovea; 18 R.I., inferior rectus; 19 O.N., optic nerve; 20 R.S., superior rectus; 21 L.P., levator palpebrae; 22 C.A., choroid artery; 23 V.V., vortucose vein; 24 V.H., vitreous humor

main chamber of the eye, is occupied by a clear jelly, the vitreous humor (*V.H.*).

The eye is contained in and protected by a conical cavity of the SKULL, the orbit. It is moved by six muscles. Four of them converge in the back of the orbit, at its apex. These muscles are the recti. The rectus superior (*R.S.*) is attached on the upper aspect of the eyeball, the rectus inferior (*R.I.*) on the lower aspect, the rectus medialis on the side toward the nose, and the rectus lateralis on the opposite side. The other two, the superior and inferior oblique muscles are attached behind the recti, and in such a manner that they pull in an axis at right angles to the direction of the recti (*S.O.*, *I.O.*).

The optic nerve (*O.N.*) enters the orbit at its apex, between the attachment of the ocular muscles. It

which secretes tears into the conjunctival sac. The remainder of the space in the orbit is occupied by fat. See also VISION, EYE, AFFECTIONS OF. W. J. S. K.

EYE, AFFECTIONS OF. Diseases of the eye follow the general rule of disease as it affects the rest of the human body, to which are added the particular forms of disease indigenous to the specialized character of ocular tissues. Injuries and tumors form a separate section that must be read and translated somewhat differently here than elsewhere. Under malformations of the eye structures come the variations in shape and size of the eyeball that lead to errors of refraction and the necessity of glasses. And so in considering affections of the eye, it is rather essential to approach the problem first from the general standpoint and then from the standpoint of isolated disease

of the various ocular structures. (See Anatomy in preceding article on EYE.)

First and foremost, numerically, come the *infections* that may attack the eyelids, eyeball, or eye socket. The majority of such infections arise from outside sources, such as contaminations by dust, dirt, air, fingers, water, soiled linen, and the like, and the seriousness of the infection depends upon the virulence of the infecting organisms, the resistance of the tissues attacked, and the character and location of the tissues.

The Conjunctiva. *Conjunctivitis*, or inflammation of the conjunctiva, is the most common form of ocular infection. It may be due to any one of several organisms, and may be mild or so severe as to cause loss of eyesight. Generally there is burning and smarting of the eyelids, secretion of pus and tears, and visible reddening of the conjunctiva and, sometimes, the eyeball. Treatment is ordered according to the character of the infecting organism and it may vary from a simple eyewash or eye drops to extensive and long-continued therapy necessary in granular conjunctivitis or *trachoma* (see TRACHOMA). Another extremely severe form of infection of the conjunctiva is that due to the gonococcus, resulting in *gonorrheal ophthalmia* or, as it is called when occurring in newborn infants, *ophthalmia neonatorum*. (See CHILDREN, DISEASES OF; Injuries of the Newborn; OBSTETRICS.) This may spread to the cornea, causing a severe ulcer with partial loss of sight, or to the interior of the eyeball with a resultant complete loss. As a preventive measure, half-hourly day and night treatment is needed, and every case of gonorrheal ophthalmia, whether in adult or infant, should be hospitalized immediately.

In the eyelids are numerous small glands that normally secrete a small amount of oily material to lubricate the passage of the eyelids over the eyeball. When one of these glands becomes infected, there results a *hordeolum*, commonly known as a *STYE*, which in a few days comes to a head, ruptures, and discharges a few drops of pus. Unless the source of infection is eliminated, one stye follows another, persisting for a long time. Sometimes the stye does not open, but subsides gradually, leaving a small hard lump, known as a *chalazion*. This is a small cyst, filled with granulation tissue, painless, self-perpetuating, and tending to enlarge. Incision of the chalazion and curettage insures permanent removal of the cyst.

The Lachrymal Passage. Infection of the lachrymal gland is called *dacryocystitis* and occurs not uncommonly in older people. It manifests itself by a reddened swelling near the inner corner of the eye and the discharge of a large amount of pus. Pressure over the swelling will force out more pus. Many cases can be cured by treatment, but many require surgical removal of the tear sac.

The Cornea. One of the most dangerous infections of the eye, so far as sight is concerned, is found in *corneal ulcer*. It may be due to any organism. If the ulcer is located over the pupillary area of the cornea, vision may be seriously interfered with; but

toward the edge of the cornea, it will not interfere in the slightest. Of all ulcers of the cornea, the most severe are the *serpiginous ulcer*, due to the pneumococcus, and the *gonorrheal ulcer*, due to the gonococcus. In both of these, destruction of corneal tissue is rapid and extensive and only the most radical of measures will prevent perforation of the cornea with resultant infection of the interior of the eyeball and complete loss of vision.

There are two other diseases of the cornea formerly common in this country and still very common abroad. The first is known as *phlyctenular keratitis*. It attacks children before the age of puberty and manifests itself as a severe ulcer of the eyeball, with intense aversion to light (photophobia) and an excessive flow of tears. The patients are invariably those suffering from malnutrition, enlarged glands, frequent nasal colds, and the other usual sequences of poor living hygiene. Tuberculosis is believed by many to play a rôle in the causation. The little sufferers should be treated in a hospital, but the course is apt to be long drawn out. Scarring of the cornea may result and recurrences are frequent unless the hygiene is corrected.

The second is known as *interstitial keratitis*, and is invariably due to syphilis. It appears somewhat later in life and always affects both eyes sooner or later. Injury to the eye may be a cause, but that alone is not sufficient. After a short period of photophobia, the cornea gradually becomes gray and translucent and new blood vessels begin to enter the otherwise avascular tissue. This may proceed until the entire cornea has become a salmon pink. Active treatment must be aimed at not only the local condition, but also the underlying syphilitic factor. The disease is always prolonged over many months and the resultant vision is apt to be seriously interfered with.

Although the above infections arise from external sources, infecting organisms may reach certain internal parts of the eye by way of the blood stream. Unless the resistance of the ocular tissues can overpower the germs, there will result a generalized infection of the entire intra-ocular contents, producing the condition known as *panophthalmitis*. The eye is almost invariably lost, but fortunately such cases are rare. However, panophthalmitis results not infrequently after injury in which the eyeball is perforated. (See below, Perforating Injuries.)

Internal Structures. Disease of the internal structures of the eye is apt to be more serious than disease of the external structures. In practically all cases, there is some systemic cause that must be found and removed before the eye condition can be relieved. Glandular tuberculosis, syphilis, infection of the teeth, tonsils, sinuses, etc., high blood pressure, kidney disease, diabetes—in fact, practically any condition in which poisons are produced that may be carried to the eye by the blood stream, must be searched for and weighed carefully as a possible cause. The inflammations of the various structures of the internal eye will vary enormously in intensity and in severity, according to the tissue involved and according to the loca-

tion. Many of the conditions are so mild that they may cause no annoyance until well advanced. On the other hand, some develop to their full severity within a remarkably short time. In either case, the cure is slow as but few of the structures of the internal eye can be attacked by direct medication.

The Iris. The iris is particularly susceptible to inflammation. Such disease is known as *iritis* or seeing that it always involves a neighboring structure, the ciliary body, *irido-cyclitis*. Any of the systemic factors spoken of in the preceding paragraph may be the cause of iritis and upon establishment of the diagnosis, a search for the causative factor must be instituted immediately. As a rule, iritis appears insidiously and the patient is unaware of any serious trouble for several days or even weeks. Then the persistent redness of the eye, the pain, which may be slight or may be very severe, the dimness of vision, and the aversion to light force him to seek relief. The inflamed tissue must be put at rest, which is accomplished by instilling atropine into the eye, resulting in a dilatation of the pupil. If the causative factor can be found and removed within a short time, the attack of iritis will be of short duration. But in nearly half the cases, the cause cannot be located or else several coincidental causes will be found whose removal requires time. Only too frequently, will iritis recur after a lapse of time, despite apparent removal of the cause, providing that there was more than one underlying factor. Iritis is dangerous to the integrity of the eye, both visually and cosmetically, owing to the great tendency for adhesions to form between the pupillary edge of the iris and the anterior surface of the lens that lies immediately underneath. An eye with iritis must not be touched surgically except in great emergency, but frequently the excision of a small piece of iris tissue (iridectomy) is beneficial in preventing the recurrence of iritic attacks. Disease of the ciliary body alone, which is adjacent to the iris, is known as *cyclitis*. It is essentially chronic in nature and is most frequently due to tuberculosis or syphilis.

The Lens. The lens has no blood vessels or nerves and receives its nourishment from the aqueous humor in which it is bathed. Consequently, there is no inflammation of the lens unless infecting germs are introduced into the lens, either traumatically or surgically. The lens is entirely surrounded by a capsule which acts as a filter, keeping out water and other undesirable elements of the aqueous humor, but allowing nutrient substances to pass into the interior of the lens. When the capsule is mechanically broken, the aqueous humor permeates throughout the lens and causes a coagulation of the otherwise transparent lens fibers. This process renders the lens translucent, a condition known as *traumatic cataract*. In embryonic life, the capsule is sometimes deficient in those qualities that permit proper filtration and the child is born with the opaque lens of *congenital cataract*. Often toward adult life, the capsule gradually becomes somewhat less permeable and the nutrition of the lens is slightly interfered with. The resultant opacity is

usually in the periphery of the lens, thus not causing disturbance in vision, until the opacity has progressed to the center, along lines resembling the spokes of a wheel. This condition is known as *senile cataract*.

The only treatment for cataract is surgical. Since the beginning of the history of ophthalmology, attempts have been made to arrest beginning cataract medicinally, but practically never have the successes reported by author of any one form of treatment been duplicated in any measure by others. The medical treatment of cataract has proven one of the most fertile fields for the ophthalmic quack, but the fact still remains that the only cure for cataract lies in surgery. Different operations are, of course, needed for the removal of cataract in various forms. With modern technique and modern asepsis, good visual results follow in 97% of operations of senile cataract.

Coats of the Eye: Sclera, Choroid, Retina. A little more than three-fourths of the eyeball lies behind the lens and this consists of the rigid outer coat (the *sclera*) which is lined by a delicate membrane of blood vessels and pigment (the *choroid*) and on the inner surface of this is the membrane of light perception (the *retina*). These membranes surround a large cavity that is filled with a perfectly transparent gel, known as the *vitreous*. Normally, light rays pass through the vitreous without any hindrance, but if any floating speck lies therein, that speck casts a shadow upon the retina. Such specks are called *muscae volitantes* or *vitreous opacities* and may vary from the most innocuous of conditions to serious hemorrhages that destroy the sight.

The *retina* and *choroid* lie so close together, that almost invariably any inflammation that affects one membrane affects both. Consequently, one can speak but seldom of *retinitis* or *choroiditis*, but usually of *retino-choroiditis*. Such inflammations may be very mild, such as commonly occur in the slight elevations of blood pressure of old age, or very severe, as is frequently seen in an exaggerated case of diabetes or of Bright's disease. Any degree of severity between these two extremes may be looked for. The cause invariably lies in systemic disease elsewhere in the body, such as syphilis, tuberculosis, nephritis, or any condition in which poisons are generated that may be carried through the circulating blood. The patient may be unaware of any ocular disorder and the trouble may be found only upon examination with the ophthalmoscope. But the moment the disease advances toward the posterior pole of the eye, the vision of that eye becomes diminished, although no pain is experienced nor does the eyeball become reddened as in iritis. Upon diagnosis of the condition, an immediate search for the cause is indicated and steps toward amelioration of that cause must be instituted. Local treatment of the eye is of but little avail. The ultimate vision of such an eye depends upon several factors, primarily the location of the lesion and secondarily the ability to eradicate the cause before irremediable damage has been done. In these cases, close teamwork between the oculist and the diagnostician is essential.

The retina normally lies flatly on the inside surface of the eyeball; in some cases it changes position, so that some part of the retina floats forward into the vitreous and there results the condition known as *detachment of the retina*. This occurs most frequently in very nearsighted eyes, but may be the result of injury or of disease. Pregnancy is a not uncommon causative factor, but fortunately the detachments occurring in pregnancy are apt to reattach spontaneously. As soon as any part of the retina is detached, the vision of that part becomes seriously impaired and unless a reattachment occurs within a reasonable length of time, vision is permanently lost. In a few cases, absolute rest in bed and dehydration will assist the retina to return to its normal position. In the remainder of the cases, the only relief is by an operation that is a product of recent years. Even then, the percentage of recoveries is only about 15 per cent.

The Optic Nerve. Entering the back of the eyeball is the optic nerve, which in reality is not a true nerve at all, but rather an extension of the brain. Through this nerve are transmitted the impulses from the retina which has been stimulated by light entering the eye. Any interference with the optic nerve, whether it be inflammation or actual blockage, results in an interference with vision. Inflammation of the optic nerve as it enters the eye is called *papillitis* or *optic neuritis*, and is a disease entity due to much the same factors that may cause retinitis. If the inflammation occurs in the optic nerve between the eyeball and the place where the nerve enters the cavity of the skull, the trouble is known as *retrobulbar neuritis*. Owing to the different anatomical relations, such disease is usually due to a nervous disorder recognized as multiple sclerosis or to extension of disease of the accessory nasal sinuses. Manifestations of brain tumors may frequently be seen in the optic nerve as an early sign. When the entrance of the optic nerve into the eyeball is swollen and mushroomed forward into the vitreous, it is a condition called *papillo-edema* or *choked disc*. When this is found, the case should pass from the hands of the oculist to those of a neurologist.

Glaucoma. One of the most dangerous of all diseases of the eye is glaucoma, which is the cause of a large proportion of the blindness that exists to-day. The cause of this dread disease is still unknown. The principal manifestation is an increase in the pressure within the eyeball (*see GLAUCOMA*).

Penetrating Injury of the Eyeball. This is fraught with a danger that is peculiar to the eye. Following an injury by which the eyeball has been opened, either by trauma or by operation, and which has caused a persistent inflammation of that eye, there may develop a serious inflammation of the other eye, known as *sympathetic ophthalmia*. This does not occur until at least fourteen days after the primary injury, most usually appears in from four to six weeks, but may occur many months or even years later. Fortunately, the appearance of the injured eye gives a clue as to the possible onset of such an inflammation and in the majority of cases, proper pre-

ventative measures are applied. These consist in the prompt removal of the injured eye before any signs of inflammation have appeared in the second eye, for if that has become involved, then removal of the offending eye is useless. Many theories have been advanced as to the cause of sympathetic ophthalmia, but as yet, none have stood the test of time. As an immediate sequel to penetrating injury of the eyeball, there may result a severe infection that involves all of the intra-ocular structures. This condition is known as *panophthalmitis*. Vision is entirely lost and, in the majority of cases, it is necessary to scoop out the contents of the eyeball to prevent spread of the infection.

Tumors of the Eyeball. Tumors may be either benign or malignant and may be found in either the external or internal structures. Those of the *external type* are most apt to be benign and are usually discovered early. In many instances, they can be removed by X-ray or radium or by operation and are not apt to recur elsewhere in the body. But tumors of the internal eye are usually malignant, the most common being *melano-sarcoma*. True *carcinoma* does occur, but it is usually secondary to carcinoma elsewhere in the system. In practically all cases, the only treatment is complete removal of the eyeball as early as possible, and even then a certain percentage of the tumors recur elsewhere in the body within two years, most frequently in the liver or spinal cord. In infants, there is a most malignant tumor called *glioma* that nearly invariably involves both eyes and is almost always fatal, due to extension into the brain.

Malformations. In the normal individual, when looking at a distant object, the axes of the two eyes are parallel. When such parallelism is missing, the condition of *strabismus* is said to exist. If the axes converge toward each other so that the eyes look toward the nose instead of parallel, it is known as *convergent strabismus* (inward squint or cock-eye); whereas, if the axes diverge, there exists a condition of *divergent strabismus* (outward squint or wall-eye). If one eye fixes upon the object and the other turns either in or out, the type of strabismus is known as *concomitant convergent* or *concomitant divergent strabismus*. But if either eye is able to fix upon the object while its fellow turns in or out, it is known as *alternating convergent* or *alternating divergent strabismus*. The above are the types that develop in childhood and are the most common. Seldom are children born with an actual strabismus, but merely with the tendency toward the condition; it requires the breaking down of general muscle tone to make the condition manifest. Of the concomitant squints, about 85% can be straightened by glasses and orthoptic training, if started early enough (before the third year of life). The 15% of the cases resistant to treatment require surgical intervention before it is too late, for the cure of this type of squint is intimately associated with the development of *binocular vision* and *fusion*. These faculties seldom can be developed after the seventh or eighth year of life. The alternating type does not yield so easily to training and nearly 50% of the cases

require operation before parallelism of the visual axes is obtained.

Still another type of squint is that which results from paralysis of one or more of the extra-ocular muscles that move the eyeball. Injury and syphilis are the most common causes of such *paralytic squint* and before treatment can be instituted, the cause must be run down. The outcome of the case depends upon the cause, the intensity of the treatment, and the degree of resistance of the patient. Lack of parallelism of the visual axes when at absolute rest, but overcome by involuntary effort upon use of the eyes (in other words "latent squint"), is extremely common and is known as *heterophoria*. According to whether the visual axes tend to deviate inward or outward or upward or downward, the condition is termed *esophoria*, *exophoria*, *hyperphoria*, or *hypophoria*. In the majority of people, a moderate degree of heterophoria causes no discomfort and passes unnoticed throughout their lifetime; but in some, the condition causes marked discomfort and can be relieved only by the use of prisms or even operation.

Deformities of the lids may result from injury, or disease, or contraction of scar tissue. If the upper eyelids droop so as to cover the eyeball more than normally, the condition is known as *ptosis*, which may be congenital or may be due to a weakness of the muscles that lift the upper lid. Unless such weakness is the result of curable disease, surgery offers the only relief for ptosis. On the other hand, if the droop is in the lower eyelids, so that the inner surface is partially everted and is exposed to the air, it is called *ectropion*. This condition causes extreme annoyance, owing to the drying of the exposed mucous membrane that lines the eyelids, in addition to which it is extremely unsightly. Surgical intervention offers a prompt cure. Inversion of the margins of the eyelids produces an *entropion*, which is not as unsightly, but is more annoying and even more dangerous than ectropion. Here the eyelashes rub against the eyeball, keeping up a state of continuous irritation that may eventually lead to ulceration. Surgery offers the only relief. If by reason of protrusion of the eyeball or by faulty closure of the eyelids, the front of the eye is continuously exposed to air and dirt, a generalized inflammation of the front part of the eye results that is called *keratitis e lagophthalmos* (inflammation of the cornea due to insufficient closure of the eyelids). The cure lies in the protection of the eyeball, either by continuous application of grease, or mechanical closure of the eyelids by adhesive plaster or by suture.

The condition popularly known as pop-eye is technically *exophthalmos*, which means a protrusion of the eyeball. Inasmuch as the eyeball is located at different depths in different people, it is impossible to say that an individual has an exophthalmos unless the protrusion varies from the normal state. The usual measurement is from the apex of the cornea to the outer margin of the bony eye socket. Exophthalmos may be due to a variety of conditions and may affect one or both eyes. The most common cause is the pro-

trusion that accompanies toxic or exophthalmic goiter, in which the eye symptoms are of great importance. The exophthalmos may increase so rapidly in this condition and may be so great that immediate removal of the goiter is called for. As a rule, after thyroidectomy, the exophthalmos recedes to normal, but not always. Unilateral exophthalmos requires nicety of judgment of the underlying cause. Most frequently there is a tumor of the orbit behind the protruding eyeball, but there are numerous other conditions, more or less rare, that may cause it. H. S. G.

EYE PREPARATIONS, cosmetics for beautifying the eyes. They consist mainly of mascara and eye pencils for darkening the eyelashes and eyebrows. Eye lotions, which cleanse and relax the eyes after undue exposure and eye strain, may be considered therapeutic. *Creams* with a lanolin base are sometimes used to counteract wrinkles and dryness of the skin around the eyes. *Makeup* of the eyes consists of darkening the upper and lower lids of the eyes with an eye pencil of a suitable shade, darkening the eyelashes and eyebrows with mascara, and of arching the eyebrows which is often done by plucking stray hairs with tweezers.

Eye pencils are firm wax-like pencils in various shades designed to suit the color of the eyes and of the hair. Black, brown, gray, blue and violet are the principal shades. They are intended for darkening the upper and lower lids to make the eyes appear larger and more luminous. *Mascara*, which comes in cake form and is applied with a brush, is for darkening the eyelashes. It is usually made in two colors, brown or black. The use of cosmetics for the eyes is considered more "extreme" than makeup for the face, but in recent years it has gained in popularity.

G. R. F.

EYE PROTECTION. See ACCIDENT PREVENTION.

EYRA, an active South American wild cat (*Felis eyra*), weasel-like in the length and slimness of the body, and shortness of the legs. It is about the size of a large housecat, but more slender. Two color phases seem constant: in one, the fur is pepper-and-salt gray; in the other phase, it is rusty red. It ranges in forests southward from Texas throughout the American tropics, but is uncommon north of Panama. It is rarely tamed. This species is also called jaguarundi.

EYRE, the largest lake in Australia, a shallow body of water with an area of approximately 3,000 sq. mi. lying 39 ft. below sea level. Lake Eyre is located in the northeastern part of South Australia, directly north of Spencer Gulf. It has two arms; the southern arm contains salt water, but the northern is merely a salty marsh except during the rainy season. At flood times a great number of central Australian rivers enter the lake, including Cooper's Creek and the Warburton, both large streams. Long droughts and the terrific heat of the surrounding country cause the Eyre to be called "the Dead Heart of Australia," and the region is sparsely settled. Geologically, the Lake Eyre basin dates from the late Mesozoic period. Ages ago it

had an outlet and was three times its present size; now it is drying up, due to gradual elevation.

EZEKIEL, BOOK OF, the third of the major prophetic books of the Old Testament, is named after a Hebrew prophet, who was carried captive to Babylon in 597 B.C., and who at an early age began a ministry of 22 years in the Jewish colony at Tell-abib and elsewhere near Babylon. Although many still regard the book as an autobiography of the prophet and his visions, a large number of modern scholars view it rather as an exposition of his ideas. Its general unity is seldom questioned. At the time the Hebrew canon was formed, this book narrowly escaped being included in the Apocrypha. Its divisions are very definite, representing the successive stages of the prophet's ministry. The visions in Chapters 40 to 48 furnished the Jews with much of their national idealism. With the work of Augustine in mind, one has even written, "What the *civitas Dei* was to medieval Christendom, the vision of Ezekiel was to post-exilic Judaism." In each case it might be claimed that the book provided the ideal which molded the polity of the age which followed. What the book lacks in the idiomatic purity of its language, it makes up in a strong imaginative style.

EZRA, in Biblical account, prophet and priest and Hebrew scribe at the time of the return of the Jews from Babylon, about 450 B.C. He lived probably during the time of the Persian King Artaxerxes I and was the author of the canonical book of the Bible entitled Ezra, with which the Book of Nehemiah is generally associated by scholars. Considerable so-called Ezra literature is ascribed to Ezra and modern scholars have maintained that Ezra closed the canon of the Old Testament. He is also regarded by Talmudists as the founder of the Great Synagogue and as the earliest of the great scribes.

EZRA, BOOK OF, in the Old Testament, is counted part of I and II Esdras in the Douay version. In the Hebrew it forms one book with NEHEMIAH. Because Ezra was a scribe as well as priest, this book and others have been attributed to him. Two or three of its chapters were originally written in Aramaic, and many scholars hold that its present form dates from the 3rd century B.C. Its first division concerns the life of the Jews from the time of Cyrus to the sixth year of Darius Hystaspis, and the last part of the book to the seventh year of Artaxerxes. Ezra's legislation on mixed marriages is an important element in the last part.

F

FABIAN, ST. (d. 250), was made Pope in 236. He did much to improve Church organization and appointed officers to keep the records of martyrs. The Emperor Philip is said to have been baptized by him. He was instrumental, too, in founding churches in France. During the persecution of Decius in 250 he was martyred.

FABIAN SOCIETY, an important Socialist organization in England, founded in 1883 for the propagation of principles essentially different from those of Marx, which dominated British revolutionary Socialism at that time. The Fabians believed that Socialism could in large measure be adopted, and evolved, through the agency of existing parties. They urged the nationalization of land and such industries as could be conveniently managed socially, and they worked also for the amelioration of social conditions. They took their name from the Roman Fabius, with his policy of victory by delay.

George Bernard Shaw, Sidney Webb (later Lord Passfield), Sydney Olivier (later Lord Olivier), Graham Wallas and Mrs. Annie Besant were among the Society's early members. The Fabians published books and pamphlets, gave lectures, formed local organizations, and attained an influence quite out of proportion to the society's numbers, which were never very large. In 1900 they aided the trade union bodies in the formation of the British Labor Party.

FABIUS, QUINTUS MAXIMUS (c. 275-203 B.C.), Roman general and statesman at the time of the SECOND PUNIC WAR. He was appointed dictator in 217 B.C. after Rome had suffered defeats at the Ticinus River and at the Trebia, 218 B.C. and the army of the consul Flaminius had been routed at Lake Trasimene, 217 B.C. Keeping close to Hannibal and harassing his foragers, yet carefully avoiding a decisive engagement, he helped the Romans recover their confidence. By these tactics he gained the soubriquet "Cunctator," "The Delayer." At the end of six months he resigned the dictatorship. Rome's failure to continue this prudent policy in the ensuing year resulted in the crushing defeat of her army in the Battle of Cannae, 216 B.C. Fabius later, 209 B.C., captured Tarentum which had long been occupied by Hannibal. After opposing Scipio's plan to invade Africa, 205 B.C., he died in 203 B.C., before Rome's final victory at Zama.

FABLE, a lively story, either in prose or verse, designed to convey a moral lesson; the main characters are generally animals or inanimate objects having the gift of human speech.

The earliest of these tales arose in India and Greece and developed from primitive beast stories. The Indian *Panchatantra*, from which was probably derived the popular *Hitopadesa*, goes back to about

400 B.C. The Greek fables, associated in the 5th century B.C. with Æsop and first collected by Demetrius of Phalerum about 320 B.C., were latinized by Phaedrus (1st century A.D.) and turned into Greek verse about 200 A.D. by Babrius, a prose rendering of whose verses forms the modern Æsop's fables.

In medieval times, besides REYNARD THE FOX, fables were written by Odo of Cheriton (12th century), by Stricker (German; 13th century), by Marie de France (13th century) and by the Scottish poet, Robert Henryson (15th century). Lydgate (d. 1451) is noted for his *Churl and the Bird*.

LA FONTAINE (1621-95), the classic French fabulist, was preceded by the 16th century poets Gueroult, Aneau, MAROT, Corrozet and Haudent, and was followed in the 18th by Gellert, Piron, Dorat, Colardeau and Florian. Other Continental fabulists of the 18th and 19th centuries were the German LESSING; Iriarte, a Spaniard; the Italian Pignotti; and Krylov, a Russian. JOHN GAY, author of *Fifty-One Fables in Verse*, 1727, has been called "the English Æsop."

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FABLIAUX, short tales in Old French verse which were composed and recited or sung by wandering minstrels called *trouvères* and *jongleurs* chiefly in the 13th century. These lively metrical tales, humorous, cynical, satirical, realistically graphic in their depiction of coarse subjects, dealt with the common themes of everyday life and were extremely popular with the middle and lower classes.

FABRE, JEAN HENRI (1823-1915), French entomologist, was born at Saint Léons, Aveyron, Dec. 21, 1823. After a preliminary classical education, he took his doctor's degree in Paris and became a teacher in the Lycée of Avignon in 1852, later being appointed professor of physics in the college of Ajaccio, at Corsica. In 1871, he retired to Sérignon, in Provence, devoting himself to the minute observation and detailed writing which established him as the greatest entomologist of his time. All insects came under his patient, sympathetic study, but he wrote especially of spiders and coleoptera. The publication of his great work, *Souvenirs entomologique* (1879-1907) was crowned by the Institute of France, and Fabre was made a Chevalier of the Legion of Honor. Other works of importance include *La Science élémentaire* (1862-65), *Notions préliminaires de physique* (1867-70), *Les ravageurs* (1870), and *La vie des insectes* (1910), known in America, through the translation by Bernard Miall, as *Life in the Insect World*. Fabre also wrote on elementary astronomy, chemistry and botany, and was the author of countless scientific papers. He died at Sérignon, Oct. 11, 1915.

FABRIANI, SEVERINO (1792-1849), Italian educator and writer, was born at Spilamberto, Italy, Jan. 7, 1792. He studied for the Church; but his misfortune in losing his voice caused him to become interested in helping others so handicapped, and with the cooperation of the Duke of Modena he established a school for deaf-mutes. His books include *Logical Letters on Italian Grammar*, 1847, which explains his teaching methods; *Life of Countess Marie-Isolani Boschetti*, and *Life of Joseph Rinaldi*. He died Apr. 27, 1849.

FABRICIUS, GERONIMO (1537-1619), Italian anatomist and surgeon, was born at Aquapendente in 1537. He studied at Padua under Fallopius, becoming professor of anatomy in 1562 on the death of his teacher. He greatly advanced knowledge of anatomy and embryology. From him William Harvey acquired the thorough training in anatomy upon which were based Harvey's later discoveries of the circulation of the blood. Fabricius was an expert surgeon and his *Opera Chirurgica*, 1617, was long the standard textbook of Europe. He died at Venice, May 21, 1619.

FABRICS, NARROW WOVEN. See **NARROW WOVEN FABRICS.**

FABRICS TESTING. See **TEXTILE TESTING.**

FACE PREPARATIONS. Face preparations are divided into two principal groups: (1) cosmetics for the care and improvement of the complexion, such as creams, salves, lotions; and (2) cosmetics for the beautifying of the face, such as rouge, powder, lip-stick, etc. (See also **COSMETICS**; **BEAUTY CLAYS**.)

It is impossible to give a complete list of face creams or lotions, for new ones are constantly formulated purporting to perform certain services for the preservation and improvement of the complexion. The ordinary care of the skin presents the problem of (1) keeping it clean, and (2) keeping it soft and smooth so that it will not age or wrinkle easily.

Cleansing the skin is perhaps the greatest single problem of the complexion. Its health and beauty, as it can be controlled externally, depend upon it. With the prevailing use of cosmetics and the modern living conditions, especially in cities, dirt and grime become imbedded in the pores, and thorough cleansing is necessary if a clear unblemished skin is to be maintained. Soap is still the most important single cleansing agent for the complexion. However, it is frequently used in combination with one or more creams and lotions, depending upon individual requirements of the skin.

Face soaps, intended especially for the care of the complexion and for general toilet purposes (see **BATH PREPARATIONS**) are usually made by the hard milled process which reduces the water content of soap to a minimum.

In order to cleanse the skin thoroughly and without irritation, only the highest quality of ingredients should be used in a toilet soap and extreme care practiced in its manufacture. The type of toilet soap depends upon the major ingredients used. Castile soap is made chiefly of olive oil. There are so-called super-

fatted soaps containing a proportion of lanolin to make it more bland. Medicated toilet soaps, containing borax or witch hazel, purport to have therapeutic value.

Frequently the cost of soap is determined by the fineness of the perfume, and the purchase largely depends upon individual preference.

Cold cream is the most used face cream. It may be used before soap and water, as a gentler means of loosening dirt, and it may be used afterward for softening the skin. Cold creams are made generally of waxes, expressed oil of almonds, sodium borate and rose waters or other essences. More recently a mineral oil cream is being made for cleansing the skin. For very dry skin a cold cream with lanolin is used after the skin has been cleansed. This cream is called *tissue cream*, or *skin food*, terms that are unscientific but descriptive of its function, indicating that the cream replaces to some extent the natural oils lost through washing the skin or through exposure.

Also there are circulation creams for sluggish skin, and special salves and creams for oily skin.

Vanishing cream, so called because it vanishes when rubbed into the skin, is non-greasy and forms a protective film as foundation for powder and makeup (hence foundation cream). It consists mainly of soap formed by stearic acid partly saponified with alkali. It has a somewhat drying effect on the skin and is not considered good for skin that is normally dry.

Bleach creams and lotions are used to lighten the skin generally and to remove freckles and blackheads. Since any bleaching agent strong enough to take off the top layer skin must include dangerous ingredients, their use is discouraged except under the care of specialists. Astringent creams and lotions are used to contract the pores, and, as in the case of bleaches, only mild forms should be used. Face lotions seem to be increasing in popularity. There are many types that are now intended for the same purposes as creams.

Face preparations to adorn the complexion consist mainly of rouges, lipsticks and face powder and most of the finer cosmetics of this type were first imported from France, but American made preparations are apt to be more uniform and more suited to the skin of the American woman, both in color and texture.

Face rouge may be powder, paste, or liquid. Powder rouge, made in compacts, is applied with puff or pad. Paste and liquid rouges stay on better, but take practice to apply well. At one time rouge was made in three shades, "light," "medium" and "dark," intended for blondes, mediums and brunettes. To-day a single manufacturer may have as many as 16 shades of rouge to blend with various shades of skin or to suit individual taste. At first, rouge was intended only to give a healthy glow to the skin and go undetected, but more recently a decidedly artificial effect was strived for. Sometimes it is fashionable to go without rouge on the cheeks, giving a somewhat mask-like appearance; while again a more natural effect is desirable.

Face powder is one of the largest single divisions of the cosmetic business. It is the single cosmetic women find essential. Powder gives a mat finish to the skin, prevents a shine, and forms a slight protection as well. The quality of powder depends upon choice of basic ingredients, the sifting process and the perfume. The color or shade of powder is very important. Up to 1925-1926, over 95% of powder sold was white, natural (or flesh), and Rachel (or pale cream) shades. To-day fashion dictates "makeup" styles and white and flesh powders are out of style. Powder ranges from a cream to deep ochre and suntan tones. In summer, darker shades are worn, to blend with outdoor skin. The quality of powder depends on (1) the high quality of ingredients, (2) the fineness of bolting, (3) the perfume.

Lip rouge may be made in a stick or in a paste form. The *paste* is somewhat softer, perhaps a little more greasy than the stick. It is usually put up in little metal boxes and applied with the finger-tip. (See also COSMETICS).

Lipsticks are the most popular form of lip rouge. They are now generally accepted cosmetics, frankly used as an artifice to make the lips redder than nature had intended them. The best lipsticks are those that go on smoothly and evenly, and will not rub off too quickly. There is no standard color scale, although the tendency is toward type of color. There are yellow-reds which form the "light" shades of lipsticks, the neutral or "medium" reds, and the blue or purple reds which are usually the dark shades. Style trends are noted in the use of various shades of lipsticks as in face powder, certain colors being considered more fashionable at one time than at another. Lipsticks may also be white, used merely as a pomade to keep the lips soft and prevent chapping. G. R. F.

FACTA, LUIGI (1861-), Italian statesman, was born on Sept. 13, 1861, at Pinerolo, in the province of Turin, Italy. As a comparatively young man he was elected to the Chamber of Deputies, and there played an active part, being a member of the Giolittian group. He was an honest, patriotic, but not brilliant politician. He held many ministerial offices and finally in Feb. 1922 became premier of Italy. During this ministry he presided at the Genoa conference. Although he was defeated in the summer of 1922, he organized with much difficulty a new cabinet, and was in power at the time of the Fascist march on Rome. At the suggestion of Giolitti he accepted the *fait accompli* and resigned. Although at first not greatly admired by the Fascists, being called "Pincherolo," on May 18, 1924, he was named senator.

FACTOR, in mathematics, one of the component expressions which, through multiplication, give rise to another expression. In the conventional sense, 3 has no factors, the word formerly being limited to positive integers, and both 1 and the number itself being excluded. In a broader sense we say that $x^3 - 2$ has three factors, and that the three factors of 1 in the case of $x^3 = 1$ are 1, $-\frac{1}{2} + \frac{1}{2}\sqrt{-3}$, and $-\frac{1}{2} - \frac{1}{2}\sqrt{-3}$. Any one of the exact integral divisors of a whole

number is called a factor of that number, excluding unity and the number itself. All factors, together with unity, are called the ALIQUOT PARTS of the number. Thus the factors of 60 are 2, 3, 4, 5, 6, 10, 12, 15, 20, 30, and the aliquot parts are the same with 1 included. In algebra a similar definition obtains, although the letters may represent fractions. For example, a is a factor of ab , although in some cases a may be $\frac{1}{2}$ and b may be 2. Similarly we speak of $a + \frac{1}{2}$ and $a - \frac{1}{2}$ as algebraic factors of $a^2 - \frac{1}{4}$. We may also remove the limitations of the theory of numbers and speak of 1, $-\frac{1}{2} + \frac{1}{2}\sqrt{-3}$, and $-\frac{1}{2} - \frac{1}{2}\sqrt{-3}$ as factors of 1, each being a cube root of 1, thus extending the use of the term factor. The term has still further extensions.

FACTORIAL, the product of successive positive integers, 1, 2, 3, . . . n , usually denoted by $n!$ or $n!$. Its applications in mathematics are numerous. (See BINOMIAL THEOREM; COMBINATORIAL ANALYSIS; PROBABILITY.) In Function Theory the expression

$$n! = \Gamma(n+1)$$

is known as a Gamma function. A gamma function satisfies the difference equation $\Gamma(n+1) = n\Gamma(n)$, and when $n=1$, $\Gamma(1)=1$ by definition; i.e., factorial zero is unity by definition.

Other forms of expression involving the Gamma function are

$$\Gamma(x) = \lim_{n \rightarrow \infty} \frac{n!}{x(x+1)(x+2)(x+3)\cdots(x+n)} n^x$$

when n becomes infinite;

$$\Gamma(x) = \int_0^\infty e^{-y} y^{x-1} dy$$

$$\Gamma(x) \cdot \Gamma(1-x) = \frac{\pi}{\sin(\pi x)}$$

$$\Gamma\left(\frac{1}{2}\right) = \sqrt{\pi}$$

In case x is not an integer and is greater than 1, $\Gamma(x)$ can be reduced by the following formula

$\Gamma(x) = (x-1)(x-2)\cdots(x-r) \cdot \Gamma(x-r)$, where $(x-r)$ may be a fraction less than 1 but greater than zero, and then by successive transformations $\Gamma(x-r)$ can be evaluated.

Another function related to the Gamma function is known as the Beta function. It is defined as

$$B(m, n) = \frac{\Gamma(m) \cdot \Gamma(n)}{\Gamma(m+n)}.$$

Gamma and Beta functions were studied intensely by LEONARD EULER. A. B.

FACTORS OF PRODUCTION. See PRODUCTION, FACTORS OF.

FACTORY BUILDINGS. The textile industry of New England was among the first to develop an improved type of factory building affording light, sanitation and safety against fire. So-called mill construction was employed, which meant a series of isolated masonry piers supporting wood girders over which was laid a solid timber floor and roof construction. The spaces between piers and spandrels were

filled with wood sash and glass. A required adjunct of mill construction was the automatic sprinkler system which ever since has played an important part not only in factory but in many other classes of building. Insurance rates are reduced thereby to a minimum.

With the improved type of building provided by the textile industry, greater interest in factory construction became more general; more systematic planning resulted and more attention was paid to external appearance. Mill construction, though a distinct advance, still failed to satisfy many requirements for the manufacture of products other than textiles. Wood floor construction did not lend itself to the oil and water soaking incident to many processes of manufacture. Column spacings were rarely over 20 feet on centers, and these were inadequate for many purposes. Masonry piers in multi-story buildings became excessive in size, restricting glass areas. Buildings unless only one story high and top lighted were, therefore, rarely more than 40 feet wide to assure adequate light.

Steel Construction and Reinforced Concrete.

With steel skeleton construction, which was employed in some instances, an increased glass area became available; but steel unprotected, even with a sprinkler system is a greater fire hazard than masonry and heavy timber, and is more costly. It was, therefore, little used for other than wide spans. Reinforced concrete, which came into use late in the 19th century, was destined to play an important rôle in factory building. In Europe the new material was at once adopted extensively. In the United States it was employed hesitatingly at first, but with continually increasing facility.

Coincident with the development of reinforced concrete construction in the United States, a totally new industry, the manufacture of the automobile, came into existence. To the automobile manufacturer belongs much of the credit for the present-day factory building in this country. Unable from the very first to supply the demand, automobile manufacturers quickly realized the need for buildings as safe as possible from fire, multiple storied, at least 60 feet, often 80 and 100 feet wide, with an abundance of light. The new industry, headed by young enthusiasts with confidence in their product and sufficiently far sighted to plan for the future, brought about a new system of factory plan and design.

The few reinforced concrete structures which antedated the modern automobile plant still followed the scheme of mill construction. Wider spans and the use of steel sash so general to-day were first employed by the builders of automobiles. The Packard Motor Car Co. was first to build spans 30 feet in each direction, while the first steel sash in the United States of standard factory type were used in the Ford Highland Park plant.

Since those first efforts, there has been constant development in factory building. Able designers, awake to the aesthetic possibilities in the industrial field, have applied themselves energetically to the

subject and have created outstanding examples in which direct, straightforward expression of the structural element and the expansive glass areas are the prime factors. A new and characteristic type has been developed which ranks as a distinct contribution to modern-day architecture.

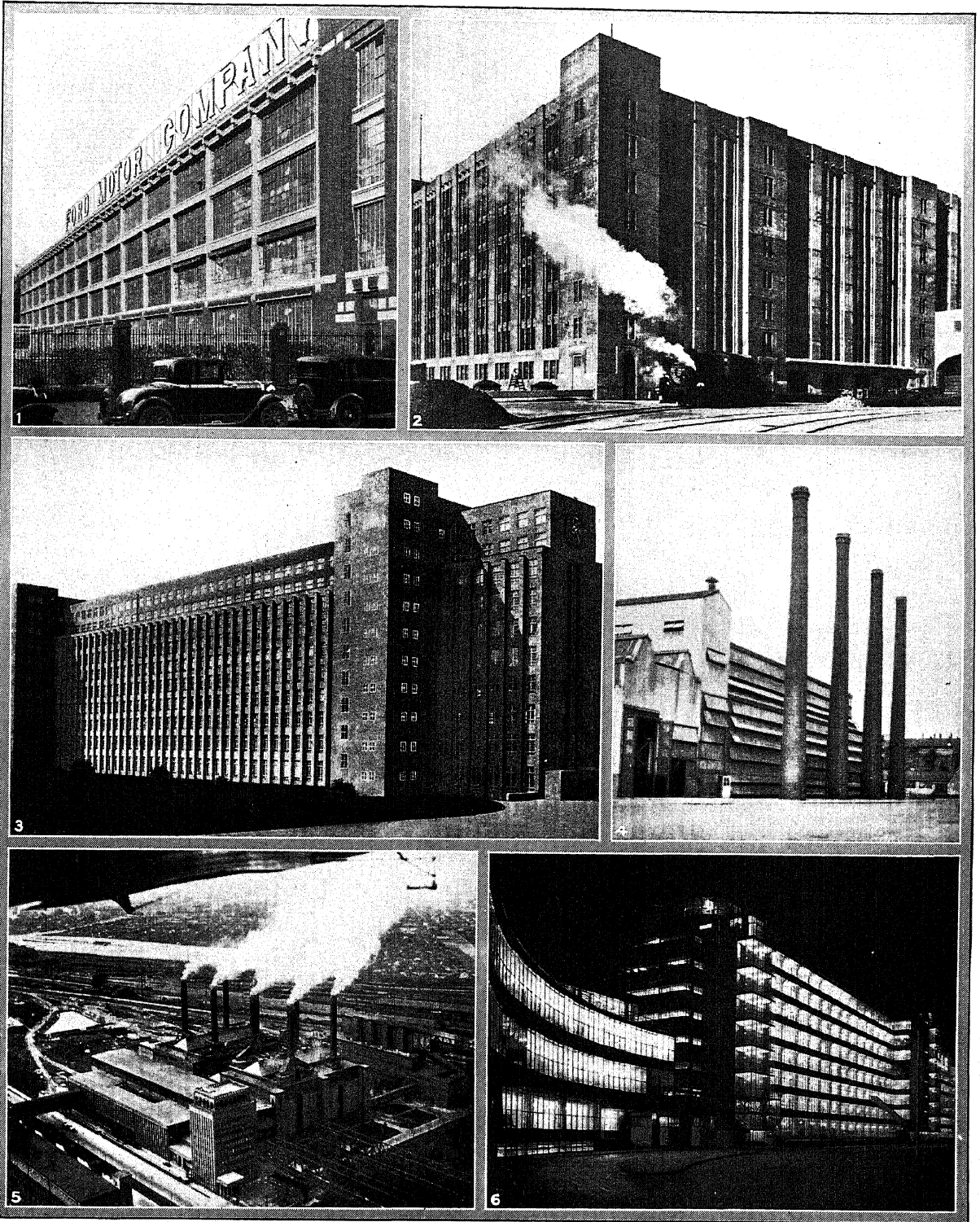
The Factory Site. The selection of the site is all important. The product to be manufactured will determine the need for railroad facilities, whether shipping or receiving by water is essential, whether the plant is best located close by or more distant from the city. Labor supply and the available facilities for reaching the plant must be considered. The character of the soil must be carefully investigated before locating. Often cheap land proves very costly in providing foundations. The topography of the land will have a considerable bearing on the layout of the plant. Water supply and sewerage must be investigated. The possibility of future expansion is all important. Land values are usually enhanced by new plants, wherefore at the outset ample ground should be made available for future growth. The railroad sidings possible on the site and their relation to the plant must be carefully considered before purchasing, for they often determine the possibilities of the plant layout.

Plan and Type of Building. The process of manufacture and the product must be the governing factors in deciding the type of building to be erected. For certain manufactures only one-story structures will serve, particularly where overhead cranes are required. Many owners prefer one-story buildings for even light manufacture and where cranes are not needed. The Ford Motor Co. unquestionably the pioneers in mass production, formerly erected five- and six-story buildings. To-day most of their plants are housed in one-story buildings, side and top lighted. While floor areas in multiple-story buildings cost less per square foot than in one-story structures, the savings effected in manufacturing in the latter type are said to more than offset the difference in cost.

As a rule, the entire floor area under one roof is preferable to segregated buildings. This makes for better and cheaper operation and maintenance, saves trucking, simplifies the conveying problem, economizes in heat and increases efficiency. Even where multiple-story buildings are needed requiring open courts between, it is advisable to use the entire ground area by covering the courts with glazed roofs at the second-story line. To lessen the fire risk in large, undivided floor areas, some building codes restrict floor areas and insist on fire walls. Such, however, have proven insuperable obstacles to manufacturing in many instances, with the result that several cities of late have modified their codes to permit unlimited floor areas in sprinklered buildings of non-combustible construction. The National Building Code of the United States Department of Commerce allows these.

Modern practice tends towards the employment wherever possible of a standard unit system of construction which permits of easy expansion and relocating of departments when this becomes necessary

FACTORY BUILDINGS



1, 4, COURTESY ALBERT KAHN, ESQ.; 2, CASS GILBERT, ESQ.; 3, 5, GERMAN TOURIST INFORMATION OFFICE; 6, HOWARD MEYER, ESQ.

MODERN TYPES OF FACTORIES, POWER PLANTS AND STORAGE WAREHOUSES

1. Highland Park Plant of the Ford Motor Company, Highland Park, Michigan. Albert Kahn, Inc., Architects. 2. United States Army Supply Base, Brooklyn, New York. Cass Gilbert, Architect. 3. Switch Gear Building of the Siemens-Schuckert Works, Berlin-Siemensstadt, Germany.

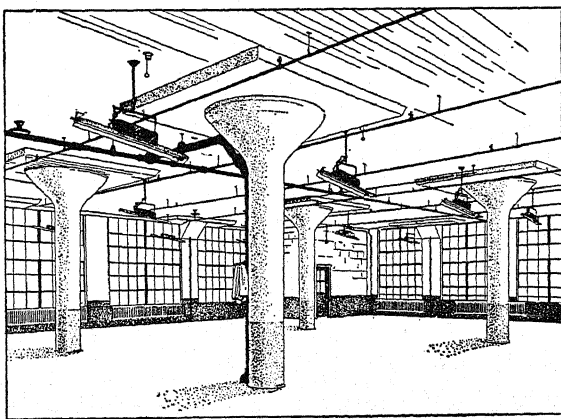
Hans Hertlein, Architect. 4. Glass Plant of the Ford Motor Company, Dearborn, Michigan. Albert Kahn, Inc., Architects. 5. Municipal Power Plant, Klingenberg, Germany. 6. Van Nelle Tobacco Factory, Rotterdam, Holland. J. A. Brinkman and L. C. Van der Vlugt, Architects.

through growth or rearrangement of the plant. Therefore, special buildings, such as power plants, foundries, forge shops or the like, are best placed where they will not interfere with expansion of the typical units. It should be possible to expand not only horizontally, but in multiple-story buildings vertically as well, by providing extra carrying capacity in columns, footings and roof slabs.

The designer of the building must have in mind the process of manufacture so that there may be continuous and direct flow from the receiving of the raw material to the shipping of the finished product. Stairs and elevators must be placed where they least interfere with the process. Internal columns should be as few as possible compatible with economy of construction, and carefully located.

For buildings requiring spans exceeding 50 feet, especially where overhead cranes are required, structural steel is best employed. Truss construction in reinforced concrete, though often used abroad where labor is cheap, is less often adopted in this country where the reverse obtains. For other types of buildings, particularly when multiple-story, reinforced concrete has been quite generally accepted. It is remarkably free from vibration, economical in both original cost and maintenance, and lends itself to speedy construction. Even in the matter of future alterations, quite contrary to the general impression, reinforced concrete has little if any disadvantage over other forms of construction. Yet fireproofed structural steel is sometimes preferable to reinforced concrete, especially in buildings exceeding 10 or 12 stories which would require excessive sizes for reinforced concrete columns.

Several forms of reinforced concrete floor construction are available. The least costly is the beam and slab type. This, however, is less free from vibration



MUSHROOM CONSTRUCTION IN A MODERN FACTORY

than either the combination hollow tile and concrete, or the flat slab construction. The latter has proven itself particularly advantageous since it avoids girders and beams, and provides flat ceilings, thereby eliminating shadows and corners for gathering dust and dirt. Flat slab reinforced concrete ceilings are not impossible even with fireproofed structural steel frames.

For the lighting of one-story buildings of large floor

area, so-called saw tooth roofs are much employed. North light is generally desirable, though some manufacturers prefer east light. More and more saw tooth construction is giving way to certain types of monitors which, in the opinion of many, afford better natural ventilation, a better diffusion of light, lessen the number of valleys and thereby decrease danger from leaky roofs. Practical experience has proven that where there is open exposure on both sides, a glass area of between 25% and 35% of the floor area gives proper light.

For the roof construction, several incombustible materials are available. For pitched roofs so-called exposed cement tiles, which are waterproofed and require no other covering, have proven very satisfactory. For flat roofs cement tile, steel decking and other materials are used. Over these either asphalt, tar and gravel, or one of the many ready roofing felts is laid for waterproofing. An insulating material, such as cork or one of the many compressed fiber materials, laid between the roof slab and the waterproofing proper makes for considerable saving in cost of heating.

For finished floor construction, cement with an approved hardening mixture added is largely used. Wood finished floors of either hard maple or wood block are desirable, though more costly. In some departments, such as tool rooms, wood floors are almost a necessity, and for heavy trucking, checkered steel tiles backed with concrete.

Whether the administrative offices are best placed within the manufacturing building or separated depends upon prevailing conditions and available funds. In general, however, they are best housed in a unit of their own, and designed for future expansion both horizontally and vertically. Provision for garaging at least the officers' motor cars is essential.

Factory buildings are not as a rule equipped with ventilating systems, natural ventilation supplying all ordinary needs. For this reason an ample number of ventilating sash and monitors should be provided. Some processes of manufacture require mechanical ventilation for the removal of fumes and dust, and some require humidifying and cooling equipment for creating the proper air conditions for drying or conditioning the product, and some require clean air passed through air filters or air washers.

For heating of the plant, forced circulation hot water is perhaps the easiest of regulation, the most economical in operation and first cost. The design of a hot water system, however, requires much practical experience and careful calculations. Low pressure steam is generally used for heating. Unit heaters prove satisfactory in certain cases, and so does blower heat. The latter, however, requires ducts and conduits for which it is often difficult to provide space.

Locker and toilet rooms are best placed adjacent to the departments they serve. In smaller plants the locker rooms may be concentrated at one point. By raising individual locker and toilet rooms in one-story buildings some eight feet above the floor (providing

easy stairs to same) much floor space is saved. Often tool rooms or wash rooms are located under these platforms. In laying out the plumbing one water closet and one urinal to every 25 men, and one water closet for every 20 women is quite general practice. Particular attention should be given to ease of maintenance and cleaning of toilet fixtures. Where women are employed, restrooms must be provided. For washing, so-called wash fountains, which are circular basins provided with a spray and accommodating from 8 to 10 men, are to-day used in preference to wash troughs or individual basins. Tempered water is usually supplied for them.

Exterior Design. Modern industry has come to realize the importance of external appearance of manufacturing buildings, the prestige gained thereby, the goodwill created and their advertising value. Owners to-day recognize also that attractive plants make for more contented workers and stimulate pride in the finished product. Accordingly, instead of entrusting the design as well as the construction to the contractor or structural engineer, so general a practice heretofore, architects are now largely employed. While the engineering problems are many, properly organized architectural firms are prepared to meet them. The competent architect has in mind not only the structural and mechanical requirements, but his especial training enables him to organize better, to plan, to correlate properly the various components of a building, and at the same time add beauty to the structure. Architects have seized the opportunity to prove that industrial building is not beyond their compass; that architecture does not mean merely applying external frills but rather systematic, orderly arrangement, proper proportion and attractive grouping.

The best results are generally the simplest, the most direct solutions of a problem in which a virtue has been made of the structural and functional requirements. The qualified architect recognizes the possibilities inherent in mere mass, size and grouping and by simplest means produces imposing structures which are at once practical and a credit to the owners and the community. Indeed modern factory buildings are among the prime achievements of modern-day architecture, for in no field has there been greater advance. There being no precedent, architects have developed what is a distinctly new type, which has in fact influenced practically all architecture of the day. Nor is design restricted merely to the buildings proper. All utilitarian necessities, such as penthouses, tank structures and the like are given proper consideration to the end that all are pleasant to look at.

Leading Architects. The industrial architecture of America has been much influenced by the excellent work done in this field in Europe, notably in Germany. Peter Behrens was among the first to show the results possible by frankly expressing the function of the building on the exterior. Many notable examples, among them particularly the buildings for the Allgemeine Elektrizitäts Gesellschaft in Berlin, attest his creative skill. Without ornamentation of any

kind, through excellence of form, proper proportion, discriminating use of materials and due recognition of the qualities inherent in size, Behrens has produced factories of exceptional beauty. Other German architects who have done outstanding work in the industrial field are Bonatz, Poelzig and Fahrenkamp. In France, Tony Garnier has been a leader. In Holland, as well as Sweden, excellent industrial work has been and is being done.

Modernism has naturally found its way into industrial building. This, as in all other fields, has often resulted in exaggerations and eccentricities. Simplicity is frequently reduced to baldness; the strange and the bizarre is too often the chief aim. Foremost among German modernists in industrial building stand perhaps Eric Mendelsohn, Walter Gropius and Bruno Taut. Their followers are legion. Among the French, Le Corbusier and Lurçat lead. Whether or not their rendition of the factory problem will prove all that many now claim remains to be seen.

A chief characteristic of much of the ultra modern work is the excessive use of glass. Even the structural element is often concealed, the glass extending in front of and past external columns, and from floor to ceiling. There is no questioning the desirability of an ample glass area in industrial building, but it is highly questionable whether superfluous glass area is beneficial. It certainly means greater cost for heating and upkeep. Modern industrial work demands the most careful consideration of economy in all respects. Excess of any kind can result only in lessening the merit of an industrial structure.

To produce the best in factory design, the proper placing of the plant and the beautifying of the grounds are important. A small sum spent for planting brings ample return, for a factory building well-designed, well-placed and beautified with grass plots and shrubbery becomes a desirable rather than an objectionable feature in the landscape of a community.

A. K.

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FACTORY LOCATION. The total cost of making a product and delivering it to competitive markets is composed of individual cost items as labor, fuel, taxes which vary widely among different localities and broad geographical areas. Hence to a large extent manufacturing and distribution costs are affected by the location of the plant.

As competition forces selling prices downward, variations of cost among plants operated with comparable efficiency but in different localities are emphasized. Such great weight has been ascribed to the economies of location that whole industries have shown a noteworthy tendency to migrate from their old sites to new ones supposedly more advantageous.

In a given case the problem is to determine that location which in consideration of all factors affecting delivered-to-customers cost of the product or products will afford the greatest advantage to be obtained

by virtue of location. By delivered-to-customers cost is meant the total of all costs which a commodity must bear from the time it is taken from nature until it is delivered to the manufacturer's customer. On the basis of computations thus inclusive, plant location affords one of the most promising fields of management strategy. *See also* INDUSTRIAL MANAGEMENT.

W. G. H.

FACTORY SYSTEMS. Although factories have existed for centuries, and the factory system is the basis of modern mass production, experts find it difficult to agree as to what a factory is. Some emphasize the numbers employed, some the use of machines, and others the discipline under which the laborers work. The United States Census defines a factory or manufacturing establishment by the standardization of its product. All these elements must be included. A factory is that type of productive unit wherein a number of workers are gathered together under one roof, laboring for fixed hours at a definite wage under a fixed discipline, at specialized processes, using tools which they do not own. It is important to note the control by the capitalist, of the laborer as to the place, time, and remuneration of his work, and the fact that the laborer does not own the tools he uses. He is also doing only one process instead of the whole task.

Factories, in the sense of central shops, have existed at many periods. In ancient times, slaves and sometimes freemen were collected under one roof to manufacture bronze and copper in Capua or pottery in Rome. Rural factories grew up in England long before the INDUSTRIAL REVOLUTION. Particularly in the west of England, workers in the woolen industry were collected together in central shops, for certain parts of the work, early in the 17th century. Sometimes the tools were owned by the workers, sometimes by the employers. Early spinning-jenny mills in the United States were of this sort. Such factories resembled those of the present day in their centralization of work. They did not, however, use power machines nor have so strict a control of the workers, and frequently in England and the United States they were set up not as independent producing units, but as parts of a production process, most of which was carried on in the homes, under the putting out system. As such they were not factories in the modern sense of the word. They frequently evolved into factories, however, as machinery developed and production was taken more and more from the home and split up into numerous standardized processes.

Another characteristic of the modern factory is production for a large and impersonal market. Under other systems of production, particularly the handicraft and domestic systems, the buyer was frequently known personally to the producer. As commerce expanded, production was carried on for distant and unknown buyers. The specialization of MARKETING, as distinct from manufacturing, coincided with the expansion of the factory system. One of the reasons for the rapid development of factories in 18th century England was the growth of England's commerce.

England was the first country to exhibit the factory system on a large scale. From there the use of the factory spread, until now the modern factory system is dominant throughout the western world. The standardization of economic life rests largely upon its development, with standardized routine for the workers and standardized products for all who buy. But this standardization makes possible cheap production and the sale of large quantities of goods at a low price. It is thus evident that the factory system could not develop on a large scale until a wide market existed, and machines were so developed as to supply this demand at a low enough cost to make profitable the initial outlay of the capitalist.

The early factories were chiefly known for their inhuman discipline, impossibly long hours, unsanitary conditions, and employment of women and children. Most of these defects have now been remedied or at least controlled by legislation. But perhaps the most important result is the development of a distinct laboring class who have nothing but their labor to sell, and who do not own the means of production. Their unequal bargaining position has led to the formation of LABOR UNIONS and created the problems of the modern labor movement.

E. W. G.

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FACTORY WASTE. *See* WASTE ELIMINATION.

FACULAE, markings on the sun's (*See* SUN) surface that appear of greater brilliance than the rest of the sun's disk.

FADING, a term applied to fluctuations in the intensity of a radio signal (*see* HERTZIAN WAVES) when the fluctuations are due to phenomena taking place between the transmitter and receiver. There is now sound evidence to the fact that the number of ionized particles in the earth's atmosphere increases with altitude for many miles. This change in IONIZATION causes a bending of radio waves in the direction of propagation. The amount of bending varies with the WAVE-LENGTH of the signal and with the condition of the upper atmosphere. It is obvious that the energy reaching any receiving ANTENNA is made up of parts coming over various paths, for energy trains start at all possible angles from the horizontal to the vertical at the transmitting antenna. If the various wave trains arrive at the receiving antenna in PHASE, a strong signal is received. If they are out of phase, a feeble signal is received. The condition of reinforcement and interference varies with conditions in the upper atmosphere.

If the fading varies over the FREQUENCIES represented by the SIDE BANDS, serious distortion may result, even though the average value of the signal is satisfactory.

L. G. H.

FAERIE QUEENE, THE, an allegorical poem of chivalry by EDMUND SPENSER, in six books of 12 cantos each; published 1590-96. This metrical romance, archaic in its diction, is written in the famous nine-line Spenserian stanza (*see* STANZA). The plan

of the work is described by Spenser in a letter to SIR WALTER RALEIGH. Gloriana, the Faerie Queene, is holding an annual feast, and on each of its 12 days, she is to commission a knight who, in order to prove his worthiness, undertakes a separate adventure. This plan, requiring 12 books, was not completed. The six finished books tell of the allegorical adventures of the following knights: Book 1, The Red Cross Knight, personifying Holiness; 2. Sir Guyon, or Temperance; 3. Britomartis, the female champion, or Chastity; 4. Cambel and Triamond, or Friendship; 5. Artega, Justice; 6. Sir Calidore, Courtesy. The allegory is manifold—sometimes religious, sometimes moral, sometimes political. Its high place in the history of literature is largely due to its exquisite music and the gorgeousness of its pictures.

FAGGING, a system peculiar to English public schools whereby a younger student is obliged to perform specified duties for an upper class pupil. In return he receives a measure of protection from the older boy. In the early days no task was considered too menial and the system was much abused, but in most schools now the duties are limited to running errands, or giving personal service at school games.

FAGIN, a Jewish thief in Dickens's *OLIVER TWIST*. He maintains an informal school where boys including Oliver are taught the technique of crime. He is later executed. The name is often applied to persons suspected of leading younger persons into crime.

FAGUET, EMILE (1847-1916), French critic, was born at La Roche-sur-Yon, Dec. 17, 1847. He was made professor of poetry at the University of Paris in 1897. He wrote a number of literary monographs, among them, *Flaubert*, 1899, *Andre Chénier*, 1902, and *Balzac*, 1913; several volumes of critical and historical literary studies, and an excellent history of French literature from the 17th century. Among his other books were *Le Libéralisme*, 1902, *L'Anticléricalisme*, 1906, and *Le Pacifisme*, 1908. He was elected to the French Academy in 1900 and to the Legion of Honor in 1901. Faguet died in Paris, June 7, 1916.

FAHRENHEIT, GABRIEL DANIEL (1686-1736), German physicist, was born at Danzig, May 14, 1686. He lived most of his life in Holland and England manufacturing meteorological instruments. He experimented with alcohol and mercury as temperature measuring-agents, about 1714 first used mercury in the thermometer and later developed the Fahrenheit thermometer and scale, still used in the United States and Great Britain. He died at The Hague, Sept. 16, 1736.

FAHRENHEIT TEMPERATURE SCALE, a scale in which the ice-point is marked 32° and the steam-point 212°. This *fundamental interval* (see THERMOMETRY) is divided into 180°. Various explanations have been advanced to account for Fahrenheit's peculiar choice of numbers for the "fixed points." One suggestion is that he chose as his zero the temperature of a mixture of ice, salt and water and that he intended to have 96° as the temperature

of the human body. The Fahrenheit scale is in common use in English-speaking countries. Fahrenheit temperatures, F., can be converted to the corresponding Centigrade temperatures, C., by the formula $C = \frac{5}{9}(F - 32)$. Thus 68° F. is equivalent to 20°

C. See also TEMPERATURE SCALES.

FAÏENCE, a term originally applied to *porzellana di Faenza*, a fine glazed pottery decorated with color and first made in Faenza, Italy, in 1299. At present the meaning of the term is indefinite. In France faïence is any ware below the grade of porcelain. In the United States the term is applied to any fine ware, whether porcelain or pottery, which is colorfully decorated. The DELLA ROBBIA family, noted medieval sculptors, designated as faïence any high grade terra cotta, with the glaze burnt in, which was artistic both as to form and color. See also PORCELAIN and POTTERY.

FAIRBANKS, CHARLES WARREN (1852-1918), American Vice-President and statesman, was born on a farm near Unionville Center, Union Co., Ohio. He worked his way through Ohio Wesleyan University, graduating in 1872. Two years later he was admitted to the bar and began to practice at Indianapolis, Ind. He became identified with Republican politics and in 1897 was sent to the United States Senate, in which he was spokesman for President McKinley. He was reelected in 1903, but resigned his seat in 1905 to accept the Republican nomination for Vice-President, on the ticket with Roosevelt. Elected, he served until 1909. In 1916 he was again nominated for the vice-presidency, to run with CHARLES EVANS HUGHES, but was defeated by THOMAS MARSHALL, another Indiana favorite son. He died at Indianapolis, June 4, 1918.

FAIRBANKS, DOUGLAS (1883-), American actor, was born at Denver, Colo., May 23, 1883. He first appeared at the Academy of Music, Richmond, Va., and made his New York début at the Manhattan Theatre in 1902. He played thereafter in vaudeville and a long succession of plays, among which were *Mrs. Jack*, *The Pit*, *A Case of Frenzied Finance*, *Clothes*, *The Man of the Hour*, 1905-08, *A Gentleman of Leisure*, *The Lights o' London*, *A Gentleman from Mississippi*, *Officer 666*, *Hawthorne, U.S.A.*, *The New Henrietta*, *He Comes Up Smiling* and *The Show Shop*, 1914. In 1915 he entered the motion-picture field, and played leading rôles in *The Mask of Zorro*, *The Three Musketeers*, *Robin Hood*, *The Thief of Bagdad*, *The Black Pirate*, *Don Q*, *The Gaucho* and *The Taming of the Shrew*, 1931, with his second wife, MARY PICKFORD.

FAIRBANKS, ERASTUS (1792-1864), American manufacturer and politician, was born in Brimfield, Mass., Oct. 28, 1792. He prepared to practice law but abandoned it to become a partner in a company manufacturing stoves and plows under his brother Thaddeus's patents. This firm, E. & T. Fairbanks & Co., also produced the Fairbanks scales. Erastus Fairbanks served in the state legislature in 1836-38, as

governor of Vermont in 1852-53 and 1860-61, and was one of the founders of St. Johnsbury Academy. He died at St. Johnsbury, Vt., in 1864.

FAIRBANKS, a town in central Alaska, the headquarters of the fourth judicial division, situated on the Chena River, about 250 miles in a straight line north of Anchorage; served by the Alaska railroad, a bus line and rivercraft. There is an airport and a Zeppelin landing field. Fairbanks is on the Richardson and the Steese highways. The Tanana Valley, which is sparsely wooded, has some fertile land for farming. Gold was discovered in the vicinity in 1903, and for a time yielded great amounts. Fairbanks is the seat of Eielson Memorial Building of Aeronautical Engineering and the Alaska Agricultural College and School of Mines. About 80 miles south is Mt. McKinley National Park. The town was founded by early prospectors; incorporated in 1906. Pop. 1920, 1,155; 1930, 2,101.

FAIRBURY, a city in southeastern Nebraska, the county seat of Jefferson Co., situated 55 mi. south by west of Lincoln, on the Little Blue River. Three railroads serve the city which is located in rich farming country. Corn and wheat are the chief crops, and cattle, hogs and poultry are raised. The city has railroad and machine shops, flour mills and large nurseries. Pop. 1920, 5,454; 1930, 6,192.

FAIRCHILD, BLAIR (1877-), American music composer, was born at Belmont, Mass., June 23, 1877. At Harvard he studied music with Paine, and later with Buonamici in Florence, and Widor in Paris. He was appointed attaché at Constantinople and Teheran. His work, which was much influenced by his stay in the Near East, includes a symphonic poem *Zal*, chamber-music, a violin concerto, several compositions for chorus, and numerous songs.

FAIRFIELD, CICILY ISABEL. See WEST, REBECCA.

FAIRFIELD, a manufacturing city of the Birmingham metropolitan area, in Jefferson Co., Ala., on the Southern and the Birmingham Southern railroads. Roberts Field airport is 2 mi. distant. Fairfield's situation in a coal and iron-mining region has furthered the development of its industries, which include the manufacture of steel, freight cars, wire, cement, bricks, tar, coke and chemicals. The retail business in 1929 amounted to \$2,731,998. The city is the seat of Miles Memorial College for Negroes and of a hospital for employees of the Tennessee Coal, Iron, and Railroad Company. Fairfield was founded originally for workers in the United States Steel Corporation's plants and incorporated in 1918. Pop. 1920, 5,003; 1930, 11,059.

FAIRFIELD, a coast town in Fairfield Co., southern Connecticut, on Long Island Sound. The New Haven Railroad serves the city. Fairfield is a popular summer resort, especially for the people of Bridgeport, 3½ mi. distant. The town was founded in 1639; a monument marks the spot where Roger Ludlowe and his followers defeated the Pequot Indians in the same year. Pop. 1920, 11,475; 1930, 17,218.

FAIRFIELD, a city in southeastern Iowa, the county seat of Jefferson Co., situated 50 mi. northwest of Burlington. Buses, truck lines and two railroads serve the city, which is a shipping point for farm produce, hay, grain and live stock. The chief manufactures are malleable castings, gray iron, washing machines and dairy and farm equipment. Lacey-Keosauqua State Park is 23 mi. south, and Oakland Mills is about 20 mi. west. Fairfield was founded in 1839 and incorporated in 1847. Pop. 1920, 5,948; 1930, 6,619.

FAIRHAVEN, a town and seaside village in Bristol Co., southeastern Massachusetts. The village is situated near Buzzard's Bay, at the mouth of the Acushnet River, on the New Haven Railroad, one mile east of New Bedford. Fairhaven has various manufactures including tacks, nails, boats and toilet powder. The town had important whaling interests from 1830 to 1857, and fishing is still carried on. The village was attacked by the British in 1778 but 150 minutemen successfully repulsed the enemy. The fort which was destroyed, was later rebuilt, and served as one of the strongest garrisons in New England during the War of 1812. Fairhaven was set off from New Bedford, and incorporated in 1812. Pop. 1920, 7,291; 1930, 10,951.

FAIRLAWN, a rapidly growing borough of Bergen Co., N.J., situated on the west side of the Passaic River facing Paterson and 6 mi. west of New York City. It is served by the Erie Railroad, electric trolleys and motor bus lines. It is the suburban residence of many Paterson and New York business men and here is located a model residential community known as Radburn. Its industries include the dyeing and finishing of silk and the dressing of furs. Pop. 1930, 5,990.

FAIRMONT, a city of southern Minnesota, the county seat of Martin Co., and about 135 mi. southwest of Minneapolis. It is served by the Chicago, Milwaukee, St. Paul and Pacific Railroad, by bus lines and has a municipal airport. Fairmont is a summer resort in the midst of an agricultural district, but with various local manufactures of railway gasoline engines, flour, bricks, tiles; there are also canning, packing and produce establishments. It was founded in 1866 and incorporated in 1886. Pop. 1920, 4,630; 1930, 5,521.

FAIRMONT, a city of north central West Virginia, and county seat of Marion Co., about 53 mi. southeast of Wheeling. The city is situated on hills both sides of the Monongahela River, the two sections connecting by bridge. It is served by the Baltimore and Ohio and the Monongahela railroads. At the head of navigation, the city is a center for shipments of the Monongahela Valley coal field and has a substantial manufacturing output, including coal by-products and glass. In 1929 the manufactures reached approximately \$12,000,000; the retail trade amounted to \$14,296,370. Oil and gas wells are in the vicinity. A series of cascades and rapids of the Tygart Valley River extend for one mile between Fairmont and

Grafton, 12 mi. southeast. Fairmont State Normal School was established in 1867. The site of Fairmont was plotted in 1819 under the name Middletown, and was changed shortly after it became the county seat in 1842. It was chartered in 1899. Pop. 1920, 17,851; 1930, 23,159.

FAIR OAKS, BATTLE OF. See SEVEN PINES, BATTLE OF.

FAIRS. See AGRICULTURAL FAIRS; MARKETS AND FAIRS.

FAIRVIEW, a borough of Bergen Co., N.J., located partly in the tidal flats of the Hackensack River and partly on the west slope of the Hudson River palisades, 2 mi. west of New York City and 6 mi. north of Jersey City, N.J. It is served by the Erie Railroad and motor bus lines. It is the residence of many New York City workers and has a number of industrial establishments, the products of which include soap, bleach textiles and dresses. Pop. 1920, 4,882; 1930, 9,067.

FAIRY RING, a delicious, edible mushroom (*Marasmius oreades*), found widely in Europe and North America. It occurs in pastures, lawns and other grassy places, appearing in summer and autumn and especially abundant after heavy rains. The plant grows usually in circles, with a slender stem, 3 to 4 in. high, bearing a buff, tawny or reddish cap about an inch across.

FAIRY TALE, strictly, a story dealing with the activities of supernatural beings or spirits entering into human affairs; loosely, any story which is patently untrue. Fairy stories in one form or another are common to all literatures from the Greek to the present day. HOMER speaks of fairy nymphs, the Arabians of *djinn*s, and other literatures of brownies, pixies, gnomes and elves. Among the most popular fairy stories are those dealing with changelings, fairy godmothers, the granting of three wishes, the endowments of good and bad fairies at the birth of children, and the tales of people who are carried off because they displeased the "little people." Some enduring and popular stories come from Perrault's *Contes de ma Mère l'Oye*, 1697, and from two books of tales published in the 19th century: *Kinder- und Haus-Märchen* ("Children and Household Tales," 1815) by the GRIMM brothers, and the *Fairy Tales*, 1825, of HANS CHRISTIAN ANDERSEN. Very few tales of lasting beauty and charm have been produced by 20th century writers, except for William Butler Yeats's drama, *The Land of Heart's Desire*.

FAIYUM. See FAYUM.

FAKIR, or **FAQIR**, strictly speaking, a Moslem, who is poor with respect to worldly goods, or in need of the mercy of Allah. Mohammed himself was not an ascetic, although a saying, "poverty is my pride," is attributed to him. He did emphasize the wealth (all-sufficiency) of Allah and the dependence of man upon Allah's bounty. The ascetic ideal (*zuhd*) in Islam shows strong evidences of Indian influence. The Moslem who seeks to fulfill this ideal, presumably at the behest of the faith itself, is com-

monly known as a *faqir*, or, in the Persian, a *darwesh* (dervish). He resembles in character the Hindu *sadhu*, or *yogi*. All are ascetics of an extreme type, seeking through self-abnegation and humility, and by physical exercises, perhaps, a spiritual appreciation of God. See DERVISH.

FALCON, a term formerly applied to the various hawks used in the sport of hawking or falconry, but now restricted to the numerous birds of the genus *Falco*, found in most parts of the world. They are small or medium-sized hawks of compact build, the female usually larger than the male, with long pointed wings, stout hooked bills notched near the tips, and exceedingly sharp, curved claws. Their plumage is usually gray or brown, variously barred and streaked and with dark bars on the cheeks. Falcons feed almost exclusively on other birds and small mammals and are among the most courageous of all birds of prey, attacking without hesitation birds twice their size. Endowed with great keenness of vision and remarkable powers of flight they are able to pursue and catch with ease the swiftest birds and animals.

The famous peregrine falcon (*F. peregrinus*), the female of which is preferred above all other birds in falconry, is found almost throughout the northern hemisphere. It is about 18 in. long, dark bluish gray above, with a black spot on the cheek, and buff-colored marked with black below. It feeds almost entirely on such birds as ducks, pigeons, grouse and partridges. Its nest, in which it lays two to four heavily spotted, brownish eggs, is usually placed on rocky ledges. In North America two forms of this bird occur, the duck hawk (*F. p. anatum*), found throughout the continent, and Peale's falcon (*F. p. pealei*), of the north Pacific coast. Other well-known North American falcons are the pigeon hawk (*F. columbarius*) and the sparrow hawk (*F. sparverius*). See also GYRFALCON; HAWK; FALCONRY. A. B. J.

FALCONER, SIR ROBERT ALEXANDER (1867-), Canadian educator, was born at Charlottetown, P.E.I., Feb. 10, 1867. He studied at Queens Royal College, Trinidad, at the universities of London and Edinburgh, and at Berlin, Leipzig and Marburg. In 1892 he was ordained a Presbyterian minister. For 15 years Falconer taught at the Presbyterian College at Halifax and in 1907 became president of Toronto University. In 1925 he was made special lecturer on American history in British universities. His books include *The Truth of the Apostolic Gospel; Idealism in National Character*, 1920, and *The United States as a Neighbor*, 1925.

FALCONIO, DIOMEDE, CARDINAL (1842-1917), American Cardinal, was born at Pescocostanzo, in the Abruzzi, Italy, in 1842. He became a Franciscan in 1860 and entered America as a missionary five years later, being ordained in 1866. The following year he was vice-president of St. Bonaventure's College, Allegany, N.Y., and in 1868 was president of the College and Seminary of St. Bonaventure. After serving as secretary and administrator of the

Cathedral of Harbor Grace, Newfoundland, and receiving ecclesiastical offices in Italy, Falconio was consecrated a bishop in 1892. Three years later he became archbishop, and in 1911, cardinal. He died in Feb. 1917.

FALCONRY, the practice of employing falcons in hunting, is of Oriental origin. It was a royal sport as long ago as 2000 B.C. Falconry was introduced throughout Europe by the Romans, but not until the 9th century was it a recognized part of the chase in Britain. In its long history, the practice of using falcons to capture and slay game has built up its own traditions and its own peculiar idioms. It will suffice to mention a few chief technical expressions. To "man a hawk" is to train the bird. To "mew" is to moult. A hawk reared from the nest is an "eyas." The various maneuvers of the bird in search or pursuit of grouse, pheasants, larks and rabbits also bear technical names. Training of the birds is complicated, requiring great skill and patience.

Before the introduction of firearms into England in the 17th century, falconry was practiced in a picturesque setting. Cavalcades of nobles and titled women went afield, the men often carrying a pet hawk on a gauntleted wrist. At the appointed place greyhounds and pointers flushed the quarry out of hedges and trees, while the falcons hovered above their masters. Once the quarry was seen, the falcon swooped upon it, whether a heron on the wing or a rabbit racing over the ground.

The sport has a small following in the United States, and is held in moderate favor in Central and South America. Falconry retains its ancient popularity chiefly in North Africa and the Orient.

FALGUIERE, JEAN ALEXANDRE JOSEPH (1831-1900), French sculptor and genre painter, was born at Toulouse, Sept. 7, 1831. He became a pupil of the master Jouffroy and in 1859 was given the Prix de Rome as a sculptor. His work in painting was also honored by a medal, 2nd class, at the Salon in 1875. In 1882 he became a member of the Legion of Honor, becoming an officer in 1878 and the Commander in 1889. He completed statues of many noted French literary figures. Among his works are *The Wrestlers*, 1874; *Cain Carrying away Abel's Body*, 1876; *Susanne*, 1879; and *Slaughter of a Bull*, 1881. He died in Paris, Apr. 19, 1900.

FALKENHAYN, ERICH VON (1861-1922), German general, was born in 1861. He was trained for the army but his career presented nothing of consequence till the BOXER REBELLION in China in 1900 after which he was made governor of Tien-Tsin. As a favorite of Emperor WILLIAM II, he was promoted rapidly after his return, appointed minister of war in 1913 and made lieutenant-general at the early age of 52. After the failure of von MOLTKE in the World War he was appointed chief-of-staff and for two years he was in supreme command of the German armies. During the first year the successes of the Central Powers, especially of Germany, were extraordinary. In 1916, however, occurred the check to Germany's

plans at Verdun, followed by severe criticism of Falkenhayn's strategy and his disagreement with the Emperor over the Balkan policy. As a result, he was superseded as chief-of-staff by VON HINDENBURG. Although the most powerful man in Germany by the end of 1915, he sank into oblivion after 1916, and was not again heard of till his death at Wildpark, near Potsdam, on Apr. 8, 1922.

FALKIRK, a municipal burgh of Stirlingshire, Scotland, situated above the Carse of Falkirk, and between the Union Canal and the Forth and Clyde Canal, halfway between Edinburgh and Glasgow. Callender House, surrounded by many evidences of Roman settlement, is associated with Mary Queen of Scots, Cromwell and Monk. Falkirk in 1298 witnessed the routing of Wallace by Edward I, and in 1746 the English defeat by Prince Charles. Falkirk's port, Grangeworth, is 3 mi. northeast. Lying in a rich coal and iron area, Falkirk is a thriving industrial town. Chemical and explosive manufactures, brewing and distilling are among other industries. Pop. 1921, 33,308; 1931, 36,565.

FALKLAND ISLANDS, a group of over 100 British islands of the South Atlantic Ocean, lying about 300 mi. south of the Magellan Strait and actually forming part of Patagonia. The total area of the group is 4,618 sq. mi., but only two of them, West Falkland and East Falkland, which are separated by Falkland Sound, are of any size. The rest are mere rocks and islets. East Falkland is 85 mi. long, 50 mi. wide and covers an area of 2,580 sq. mi.; West Falkland has a length of 80 mi., a width of 40 mi., and an area of 2,038 sq. mi. The surface is varied, being mountainous in some parts and flat and swampy in others. The highest points of land are Mt. Osborne, in East Falkland, which rises 2,245 ft. above the sea, and Mt. Adam, in West Falkland, which attains a height of 2,315 ft. The islands are watered by numerous streams which abound in fish. Sheep-farming and whaling are the principal industries. The exports are wool and whale oil; the imports coal, coke, groceries, textiles, machinery and hardware.

Falkland Islands were discovered in 1592. Settlements were established by the French, English and Spanish. In 1833 Great Britain assumed complete control of the group. With South Georgia, Graham's Land, South Shetlands, South Orkneys and the Sandwich Group, the Falkland Islands form a British colony. Stanley, population about 1,000, is the capital. The estimated population of the Falkland Islands in 1929 was 2,375.

It was off the Falkland Islands that, during the World War, the sea-fight occurred between the British squadron under Vice-Admiral Sir Doveton Sturdee and the German squadron under Vice-Admiral von Spee. Following the defeat of the British squadron under Admiral Cradock off Coronel on Nov. 1, 1914, when Admiral Cradock went down with his flagship, Sturdee was sent to intercept the German vessels and did so on Dec. 8, 1914. After an all-day running fight, five of the German cruisers were sunk, including the

German flagship *Scharnhorst*, with von Spee and all hands on board.

FALL, ALBERT BACON (1861-), American lawyer and legislator, was born at Frankfort, Ky., Nov. 26, 1861. He was largely self-taught, studying law while working on a farm. For several years he was a mining prospector in Mexico. In 1889 he began to practice law in New Mexico. He served in the legislature of that Territory, sat on its Supreme Court bench, and was twice its Attorney-General. In 1913-19 he served in the United States Senate as a Republican and was reelected in the latter year for another term of six years, but resigned in 1921 to enter President Harding's Cabinet as Secretary of the Interior. He retired from the Cabinet in Mar., 1923. In 1930 Fall was tried and convicted of receiving a bribe while Secretary of the Interior, in leasing of the Teapot Dome and Elk Hills naval oil reserves.

FALLACY, an error in reasoning. There are several different kinds of fallacies. They are usually classified as formal, verbal and inductive. Formal fallacies are those based on faulty relations between terms of the syllogism. They are deductive in character. Verbal fallacies are those due to misinterpretation of words. Inductive fallacies are those resulting from errors in the inductive process. Among the formal fallacies may be cited those of the undistributed middle and the illicit process. Thus if one argues that all who reject authority in religion are Protestants because they are non-Catholics, he has indulged in the fallacy of the undistributed middle. Verbal fallacies are very common. They are due to the misuse and ambiguity of words. Ambiguity often leads to the fallacy of four terms in syllogistic reasoning. Such words as democracy, religion, justice and freedom often need defining before intelligent discussion is possible. The statement, "All the angles of a triangle are equal to two right angles," is a good instance of a verbal fallacy. This may or may not be true, depending on the interpretation of "all."

The two most common inductive fallacies are that of hasty generalization and that technically known as *Post hoc ergo propter hoc*, the latter meaning, "after, therefore because of." A hasty generalization is due to the tendency to jump at a conclusion without having examined a sufficient number of instances to warrant it. A person meets with a few instances in which men have proved to be liars and women fickle. He then forms the generalization that all men are liars and all women are fickle. The *Post hoc* is the most common causal fallacy. Because two events have followed one another in time it by no means follows that they are causally related. Much superstition is the result of this fallacy. Other well-known fallacies are those of begging the question; circular reasoning; the various types of appeal, such as *ad hominem*, *ad populum*, *ad baculum*, etc.; and denying the antecedent and affirming the consequent.

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FALLIÈRES, CLÉMENT ARMAND (1841-), French statesman, eighth President of the Third French Republic, was born at Mézin, Lot-et-Garonne, Nov. 6, 1841. Educated for the law, he entered the Chamber of Deputies in 1876. He was minister of the interior, 1882-83, and in the latter year for a brief period premier. He served in successive cabinets until 1890, when he was elected to the Senate, of which he was eight times the president. He became President of the Republic in 1906, being succeeded by Raymond Poincaré at the end of the seven-year term. His incumbency was marked by the first application of the law separating Church and State, and for the widely divergent groups concurrently represented in his cabinets.

FALL LINE, a line of demarcation between the rocky formations bordering mountains and the softer deposits of adjacent plains. The west border of the COASTAL PLAIN from New York southward to central Georgia is at the junction of the soft, unconsolidated sands and clays of the emerged portion of the continental shelf, with hard and usually crystalline rocks of great geological age forming an upland known as the Piedmont Plateau, which extends westward to the base of the Appalachian Mts. In this zone most of the Atlantic coast rivers have formed a series of rapids; in the larger rivers these are 15 to 25 mi. long, as they flow over the crystalline rock at the edge of the old land into the valleys and channels which they have carved in the plain. The line connecting the series of rapids has long been known as the fall line. Along the fall line much water and hydro-electric power is developed and the rivers, many of which are navigable up to the rapids, furnish cheap transportation. This explains to a great extent the transference to the South of a large portion of the textile industry from New England, where most of the water power sites have been fully utilized.

FALLOPIO, GABRIELLO (1523-1562), an Italian anatomist born at Modena, was a pupil of Vesalius. He studied medicine at Ferrara, where he later became a teacher in anatomy. He died on October 9, 1562. He discovered and described the semi-circular canals, the sphenoid sinus, the ovaries, the round ligaments, the chorda tympani, the nerves of the tongue which concern secretion, taste and sensation, and also several other nerves. Several anatomic structures, notably the Fallopian tubes, bear his name. He named the vagina and placenta. He was a versatile writer on surgery, syphilis and other subjects. During his lifetime, he published but one treatise, entitled, *Observationes Anatomicae*. His collected works were published after his death. M. F.

FALL RIVER, a port city in Bristol Co., southeastern Massachusetts, situated on Mount Hope Bay, at the mouth of Taunton River, 18 mi. southeast of Providence, R.I. Bus and truck lines, steamships and the New Haven railroad serve the city. It is an important shipping point. Called the "Spindle City," Fall River has been since 1811 a leading American textile manufacturing center. In 1929 the total factory

output was worth about \$103,000,000; the wholesale trade proper amounted to \$24,893,668, and the retail to \$45,724,420. The traffic of the harbor was worth \$149,254,679 in 1929. A fire in 1843, a cholera epidemic in 1854, a strike in 1923 and another fire in 1928 have devastated the city and reduced the population, but each time Fall River has rebuilt itself. In the 1920's Southern competition in the textile industry was keenly felt, but the city, in encouraging new industries, sidestepped this disadvantage. Settled in pre-Revolutionary days and originally known as Free-town, Fall River was incorporated in 1803 and made city in 1854. Pop. 1920, 120,485; 1930, 115,274.

FALLS CITY, a city in the southeastern corner of Nebraska, the county seat of Richardson Co., situated 12 mi. southeast of Lincoln. It is served by two railroads, and ships grain, apples, cattle, hogs and poultry. The city has railroad shops and flour and feed mills. Falls City was named for the small falls of the Nemaha River, which formerly existed at this point. The city was founded in 1867 and incorporated the same year. Pop. 1920, 4,930; 1930, 5,787.

FALMOUTH, a seaport and municipal borough of Cornwall, England, situated on the shore of the Carrick Roads, an estuary entered by the Fal, about 191 mi. southwest of London. Of comparatively modern origin, in 1688 it became a port for the Royal Mail packets and thrived until the middle of the 19th century when they ceased navigating the Roads. Bartholomew Gosnold, the first Englishman to found a colony in New England sailed from Falmouth in 1602, and again five years later with the first James-town, Va., settlers. Washington Irving's mother was a native of the town. The beautifully wooded bay shore, circled by a driveway, is flanked by the lofty Tudor castles of Pendennis and St. Mawes, and the town itself boasts, beside the usual public buildings, a meteorological and magnetic observatory and a submarine mining establishment. To-day it thrives on oyster and trawl fisheries, shipbuilding and manure manufacture and is a growing center for ship-repairing. Pop. 1921, 13,322; 1931, 13,492.

FALSE IMPRISONMENT, unlawful interference with the right of another to free choice of location. The person whose liberty is thus unlawfully interfered with may maintain an action for damages for his false imprisonment.

FALSE MESSIAHS. See PSEUDO-MESSIAHS, JEWISH.

FALSE PRETENSE, in criminal law, false representations with a fraudulent design of obtaining money or property. Obtaining money under false pretenses differs from larceny and embezzlement in this: in larceny one obtains possession wrongfully from the possession of another, in embezzlement one who has possession wrongfully converts to his own use, while in obtaining under false pretenses one wrongfully obtains title by intentional false representations.

FALSTAFF, SIR JOHN, a Shakespearean character who appears in *The Merry Wives of Windsor* and in both parts of *Henry IV*. In spite of the promise

given to the audience in the epilogue of the second part of *Henry IV* Shakespeare did not bring him back, but instead describes his death in *Henry V*. Sir John is a great fat hulk of a drunken, gluttonous soldier and wit, a boon companion of Prince Henry until the latter reaches the throne.

FALSTAFF, an opera in three acts by GIUSEPPE VERDI, libretto adapted by Arrigo Boito from *The Merry Wives of Windsor* by SHAKESPEARE; première, Milan, Feb. 9, 1893; first produced in the United States, Feb. 4, 1895, at New York. The work was composed when Verdi was 80. The opera is notable for its strict continuity of action, as contrasted to the earlier Verdi method of interrupting the movement to introduce formalarias. The story is a musical paraphrase of the adventures of Shakespeare's fat knight.

FAMA, in classical mythology, the personification of rumor, later associated with evil report. The Greeks erected temples to her at Athens and Smyrna. Virgil represents Fama as a maiden, starting small in stature, but as she travels growing taller, just as stories grow with repetition.

FAMILY, a basic institution of society because it furnishes the permanent home of the man and woman united in MARRIAGE and is the nursery and training school of the young. Among western nations the typical family is monogamous, whereas in primitive tribes and certain oriental countries it may be polygamous or polyandrous. The ideal of monogamy is that one man and woman shall mate for life and shall make a stable home for their children.

In the past the family had certain highly important functions. From primitive times almost to the present the family was the center of industry. According to a sex division of labor, men generally furnished the animal food and raw agricultural products and women converted these into usable goods—into food, clothing and household furnishings for the family. Women were producers of the utmost importance in domestic economy, and every good home was a hive of industry.

The economic life of the family was transformed by the INDUSTRIAL REVOLUTION of the 18th century which took over into factories one after another of the industries once carried on in the household. In modern times the family has lost nearly all of its productive economic functions and has become chiefly a consuming unit.

A second function of the family was the instruction of the young in the religious beliefs and observances of their people. In every good family in olden times the teaching of religion, and often the conduct of domestic worship was held to be a sacred family responsibility. This custom has well-nigh vanished from western family life owing to the spread of scientific knowledge, the decline of faith in dogmatic religion and the relegation of religious instruction to the church and Sunday School.

Furthermore the family has turned over to the school most of its educative functions. Formerly children were occasionally taught to read and write at

home and were apprenticed to learn a trade in a neighbor's household. With the rise of free public school systems the educational duties of the family have been confined to a limited compass, although the educative duties remaining to parents are of great social importance.

In the past the recreations of the family centered about the family hearth-fire and lamp. To-day all this is changed and family members go their separate ways to seek amusement. Finally, the family has turned over to the state the function of protecting its members, which it once exercised in many undeveloped societies before the growth of public law.

In certain primitive tribes there exists the matronymic system, by which kinship is reckoned through mothers and property is inherited through the maternal line. Some social writers have interpreted these customs to mean that a matriarchate, or social rule by women, existed among these tribes. But the investigations of modern anthropologists have disclosed very few, if any, examples of a genuine matriarchate. Another type of family organization is the patriarchate, in which the oldest male is the supreme ruler of his family. The patriarchal family, based on father power, has endured for centuries and relics of this family type persist at present. Before the rise of our industrial civilization, most families lived on their own land and agriculture was the principal occupation. The agricultural family was united by a powerful bond—the ownership of land—and was far more enduring than the modern landless family which is mobile and unstable.

The concentration of population in cities has had profound effects upon the family. Because of the low wage paid to unskilled labor, mothers have been forced into wage-earning, sometimes to the detriment of their children and family life. Families are herded together (*see* HOUSING) in ugly slum houses, deficient in air, light, space, sanitation and the most essential conveniences. Social studies show that these homes are fertile breeding places of JUVENILE DELINQUENCY, immorality and CRIME. City life has also had a powerful influence in limiting the size of families. Children were an asset in the agricultural family; but in industrial cities, with their crowded conditions and compulsory education laws, children have become a liability. Hence the size of families constantly decreases as knowledge of contraceptives becomes more generally diffused. At present a falling BIRTH RATE characterizes all but the most backward nations. In Germany, England and America the birth rate has been cut in half in a generation.

Owing to the decline of parental power and the complexity of modern life the relationships of parents and children present difficulties which once were overcome by authority. Child psychology and mental hygiene have illuminated the behavior problems of both parents and children and the whole field of parent-child relationships has become the subject of investigation and study. Recently home economics departments have included parent-child relationships

in their courses of study and will probably enter this important field of research.

W. G.

FAMILY, in taxonomy, a subdivision of the order and made up of genera. Examples of families in botany among the flowering plants are *Gramineæ*, called also *Poaceæ* (the grass family), *Liliaceæ* (the lily family), *Rosaceæ* (the rose family), *Verbenaceæ* (the verbenace family). Examples of families in zoology among the mammals are *Felidæ* (the cat family), including the domestic cat, lion, tiger, leopard, and others; *Canidæ* (the dog family), including the domestic dog, wolves, foxes, and jackals; *Equidæ* (the horse family), including the horse genus (domestic horses, asses, and zebras), and several extinct genera. The name of a family is usually taken from one of the principal genera, adding the termination *-aceæ* in botany and *-idæ* in zoology. A family is made up of genera that show rather definite relationships. In many cases the relationships are so evident that the group in a general way was recognized as a natural one by mankind long before there was a scientific classification. Such are the grasses, the palms, and aster family (*Compositæ*); and the cat, and the horse families mentioned above.

A. S. H.

FAMILY, LINGUISTIC, a language unrelated to other known languages, as JAPANESE, or a linguistic group, as INDO-EUROPEAN, with a varying number of languages, dialects and sub-dialects, shown to be related by application of the methods for classification of language. Each member of each such group, commonly called a language, may in its turn have a varying number of subdivisions, commonly called dialects (*see* DIALECT), each of which is again capable of fission into smaller divisions.

Since language is known only from comparatively recent times, the oldest documents being no earlier than about 4000 B.C., and since many languages and, indeed, whole linguistic families, such as the "Alpine" and "Mediterranean," are known to have vanished, leaving at best scanty fragments or chance survivals in words borrowed from them by languages better known, or, again, are represented solely by modern descendants of little-known ancestors, as ALBANIAN from ILLYRIAN, delimitations of linguistic families can be regarded as valid only in the light of present knowledge, always subject to revision if further evidence be discovered. Furthermore one must bear in mind that linguistic families now regarded as distinct and unrelated may have come from a common source, the prehistoric links of their connection having been lost. Such theoretic possibilities, however, as yet devoid of cogent demonstration, e.g., the connection of Indo-European with SEMITIC, FINNO-UGRIC, or CAUCASIAN, cannot serve as a foundation for scientific classification; and such vagaries as the JAPHETIC family must be dismissed as fantastic and biased.

Subject to these reservations, the linguistic families of the world are now best classified as follows: Indo-European, Hamito-Semitic, Finno-Ugric and Samoyed, Turco-Mongol-Tungus, Japanese, Corean, Ainu, Hyperborean, Basque, Caucasian, Dravidian, Sino-

Tibetan, Munda, Mon-Khmer, Malayo-Polynesian, Papuan (?), Australian, Sudano-Guinean, Bantu, Hottentot-Bushman and American Indian, of which "American" and "Australian" are merely geographical, not linguistic, groupings, besides the extinct Sumerian, Asianic (of Asia Minor), Alpine and Mediterranean. See separate articles; AUSTRASIATIC. L. H. G.

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FAMILY ALLOWANCE. It has been customary in the United States for wage boards, students of family budgets, and workers' spokesmen to maintain that the adult male worker should receive enough in wages to support a family of five—man and wife and three children under 14. A comfort level of living, or sometimes the lower decency level, has generally been claimed as the minimum. Had all of the gainfully employed been given the wages declared necessary—women half the wage of men, juveniles 40% the wage of men, only 18% of the national income would be left to apply to all other purposes. This margin would be insufficient to supply differential wages above the minimum, and also interest, profits, rent, and savings for the replenishment and extension of productive plant. However, the family of five, held to because three children are necessary to perpetuate the race, and because an unmeaning arithmetical average yields an approximation to this figure, is as a matter of fact representative of only a small proportion of all families.

Comprehensive studies of family composition in the United States have shown that the family of three dependent children is typical of only a sixth or a seventh of the total number, two-thirds of the families having fewer than three children. Investigations abroad have shown that the standard family is less characteristic than in America. Giving each adult male worker in the United States enough in wages to support a family of five would be to provide for from 40,000,000 to 50,000,000 fictitious wives and children. While a small proportion of families have more than three children, almost 40% of the children are concentrated in these families. The family wage is more than adequate for 70 or 80% of the workers, and less than adequate for 10 to 15%. Consequently the suggestion has been widely acted upon in Europe, though the United States has not gone beyond the point of proposal, that the minimum wage should not hold to the false number of the standard family, but should be varied in accordance with the actual family need of the worker. The criticism that such a plan would cause the employer to discharge workers with dependents is met by the device of a fund to which employers in an industry or a district contribute without respect to the relative number of the workers of each having dependents. There have been earlier approaches to such a system, generally through government subsidy, the chief instance being the supplements to wages granted by the English poor law, 1795-1834.

In Europe since the World War, family allowance systems have spread widely and rapidly. The demand for a living wage, coupled with the poverty of these countries have led to the plan of additional wages to workers with dependents. Nearly every European government has such allowances for its own employees, and one or another of the schemes embraces more than 6,000,000 workers in private enterprises. Professor Paul Douglas estimated in 1925 that over one-third of wage and salaried workers in France, outside of agriculture and domestic service, were working under a family allowance system. Payments include monthly allowances for dependent children, maternity benefits, and allowances for aged parents. All of these amounted to about 3% of the pay-roll. Allowances for dependent children in Europe generally, while ordinarily progressive with the number of children in a family, are not commensurate with the expenses which children entail. The scheme is best developed in France, Belgium, and Germany. Socialist and trade-union opposition to the allowance systems is gradually weakening. B. M.

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FAMILY COMPACT, the name of two Franco-Spanish alliances and of a Canadian Tory clique. The first alliance between France and Spain was formed in 1733, the allies using the WAR OF THE POLISH SUCCESSION for making an unprovoked attack on Austria and gaining the support of Sardinia on the pretext that Austria had opposed French interests in Poland.

The second alliance, in 1761, was arranged by Choiseul, who played upon hatred of England felt by Charles III of Spain, upon his desire to regain Gibraltar and Minorca, and upon his strong Bourbon feelings. It had important consequences, constituting a breach of the Treaty of Versailles between France and Austria since it was concluded without the latter's consent. Austrian suspicions were aroused against France, and England was encouraged to try to come to a friendly understanding with Austria. This alarmed and angered Frederick the Great and a coolness developed between England and Prussia. Spain declared war on Portugal as the latter would not join the Bourbons against England. Using these developments as a pretext Bute abandoned the payment of subsidies to Frederick; the very thing that the French government had plotted to bring about. As a result of this alliance Spain was involved in the misfortunes of the treaty of Paris of 1763. See SEVEN YEARS WAR.

Canada. In Upper Canada the Family Compact covered the period 1810-40. It was a clique of Tories associated by superior wealth, social position and education, which by control of the legislative council dictated the politics of the province. They represented an informal aristocracy, particularly concerned with the maintenance of the privileges of the few and the subordination of the popular will. The com-

pact, at its strongest after 1818, effectively reduced the powers of the (elective) legislative assembly, was responsible for the **GOURLAY PERSECUTION**, secured for the Church of England the privileges of a state church in Upper Canada, and bitterly assailed **DURHAM'S REPORT**. Their opposition to union was disquieted, however, by the publication, for which Lord Sydenham was responsible, of a dispatch from the home Government making clear that tenure of public office would be contingent upon service to the governor and the province. Sir Peregrine Maitland, lieutenant-governor of Upper Canada, 1818-28; Dr. John Strachan; John Beverley Robinson; D'Arcy Boulton, and Bishop Macdonnell were prominent in the group. The compact was discredited by the mob violence which it sponsored in protest against the **REBELLION LOSSES BILL**.

FAMILY OF NATIONS, about 70 independent states of the world that are recognized as members of the international community for purposes of official intercourse. Originally, membership included only the Christian states of Europe. Today all civilized political communities enjoying substantial independence, and therefore capable of entering into relationships with other states on the basis of international law and custom, are regarded as members.

FAMILY WELFARE SOCIETY, formerly called charity organization society, a term expressing the charity organization movement whose purpose was to bring order into a chaotic field of charitable relief through organizing the charitable resources of a community. Its ideals were personal service to individual needs.

The movement was introduced in America in 1877 when the Buffalo Charity Organization Society was formed. Similar societies were soon organized in numerous cities. Gradually family welfare work assumed definite professional characteristics within the movement; emphasis was placed upon the family as the social unit and upon the development of personality and capacities of its members. Mary E. Richmond, pioneer and teacher in social work, thus defined the function of the family welfare society: "To think of the life of each family as a whole and to treat it as a whole."

In 1911, 59 private societies formed a national association for the purpose of mutual development. It was called the Family Welfare Association of America. During 1930 its 238 members assisted more than 400,000 families.

Family welfare societies are divided into three broad groups, private, nonsectarian agencies; agencies functioning under religious and racial auspices; and tax-supported agencies. M. M.

BIBLIOGRAPHY.—Fred S. Hall and Mabel B. Ellia, *Social Work Year Book*, 1929.

FANCY, a phase of the imagination; the imagination working without any check. In fancy the imagination flows along like a stream. The free play of association between ideas gives rise to fancy. Many products of this free play of association are fanciful.

The dreamer is apt to indulge in fancy. Reproductive imagination is quite different from a fanciful one. The products of creative imagination may have been regarded at one time in their development as somewhat fanciful, but as products capable of appearing before the senses they are removed from the realm of fancy. Disembodied ideas far removed from the realm of material things fall under the head of fancy.

FANDANGO, a Spanish dance, in triple meter and brisk tempo, probably of Moorish origin. Like most Spanish dances it derives much of its color and vivacity from **CASTANETS**. The dance alternates with a song of appropriate character, and both dance and song are commonly accompanied by the guitar.

FANEUIL HALL, a market place and meeting hall in Dock Square, Boston, Mass., famous in American history, and known as "The Cradle of Liberty," by reason of the many fiery meetings held there in Revolutionary days and earlier. The building, presented to the city in 1742 by Peter Faneuil, was a two-story brick structure, with a market in the basement and a meeting hall and rooms for town officers above. A fire destroyed the building in 1761 and it was rebuilt by the town in 1763. When the British occupied Boston, it was turned into a theater. In 1805, a third story was added and the capacity of the meeting hall was raised to 3,000, by moving a side wall back 40 ft. Webster, Wendell Phillips, Sumner and many other noted speakers have been heard in the hall, which is still used as a meeting place and is known also for its collection of historical paintings and portraits. Marketing continues to be carried on in the basement.

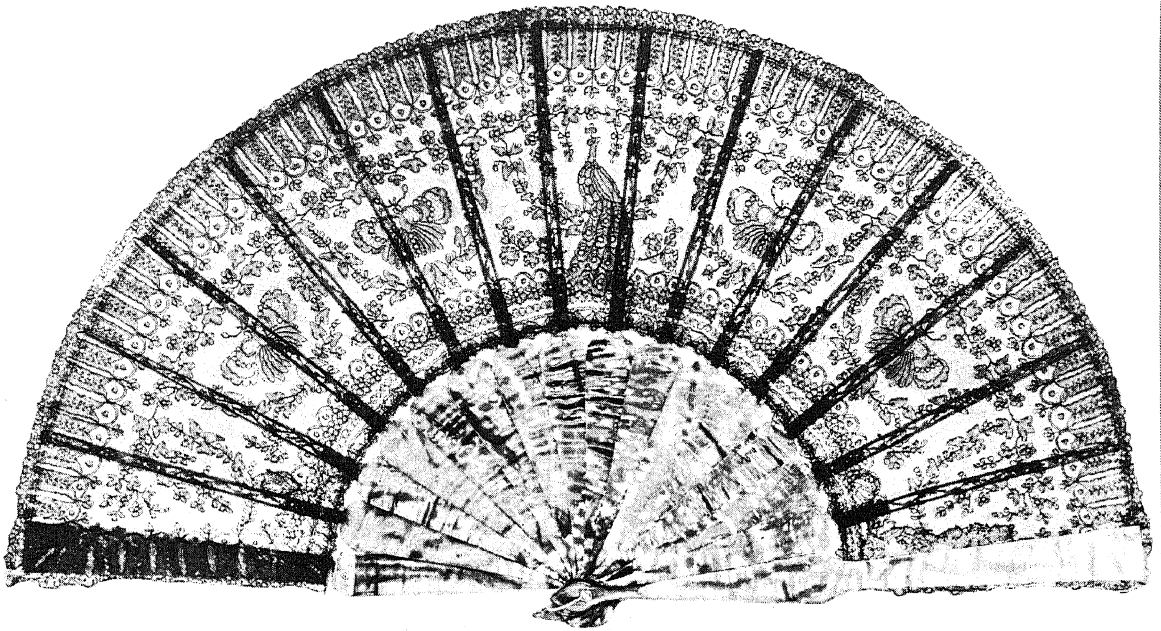
Peter Faneuil, the donor, was born in New Rochelle, N. Y., in 1700, acquired wealth as a merchant in Boston and died there Mar. 3, 1743.

FANO, an ancient town on the Via Flaminia, and once an important port, situated on the coast of Umbria, northeastern Italy. Julius Caesar occupied it in 49 B.C., Augustus built its walls. A fine arch commemorates not only Augustus but also Constantine, as a second story was superimposed in his honor. The many medieval churches are noted for their art treasures. The ancient name of *Fanum Fortunae* was derived from the temple of Fortune built by the Romans after the defeat of Hasdrubal. Pop. 1928, 28,806.

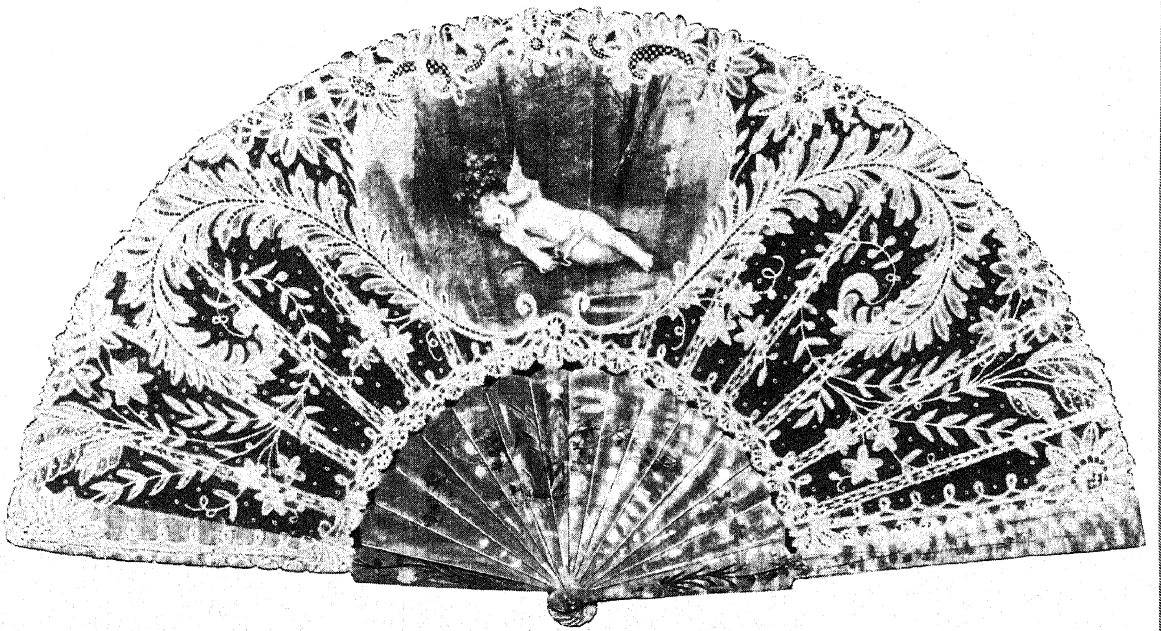
FANS, in ordinary usage, instruments which produce a current of air by movement of a flat surface. They are generally made of feathers, paper, cloth or parchment mounted on sticks of wood or ivory. These ribs may be held rigid or arranged about a pivot which allows the fan to be opened and closed at will. This last device is believed to have been introduced by the Japanese who, together with the Chinese and other Far Eastern peoples, raised fan-making to the position of a fine art.

Fans are known to have been in use in the 4th century B.C. In Egypt, Greece and India fans have been used extensively and varied in size from the small hand fan, often exquisitely painted and carved,

FANS



1



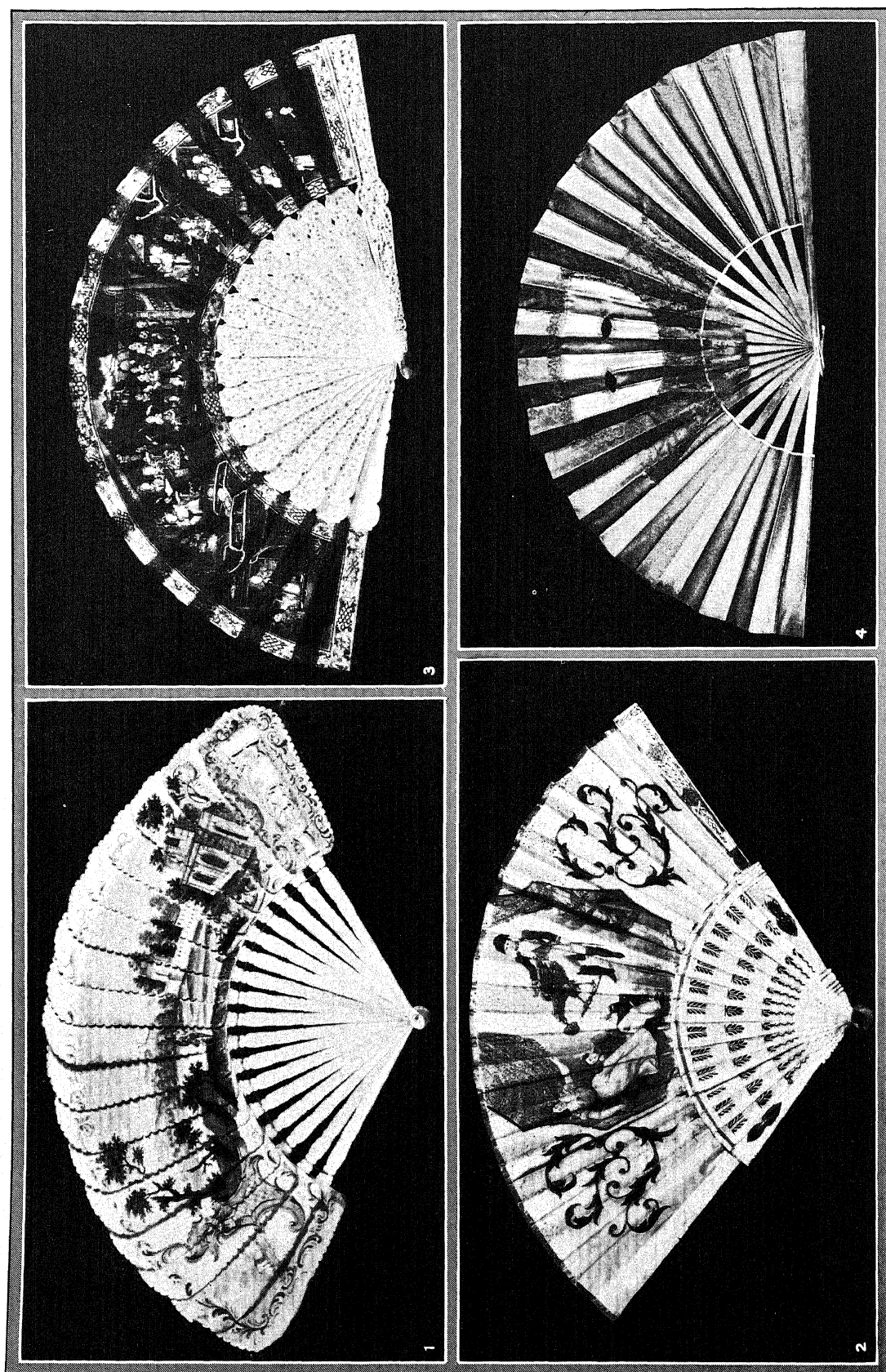
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PHOTOS BY N. LAZARNICK, NEW YORK, FROM THE COLLECTION OF THE LATE DAVID BELA SCO

FRENCH FANS OF THE EIGHTEENTH CENTURY

1. Butterfly and peacock fan executed in black lace and ivory dating from the time of Marie Antoinette.
2. An example of beautiful workmanship, the "DuBarry Fan" has carved shell sticks, delicate lace covering and hand-painted panel.

FANS

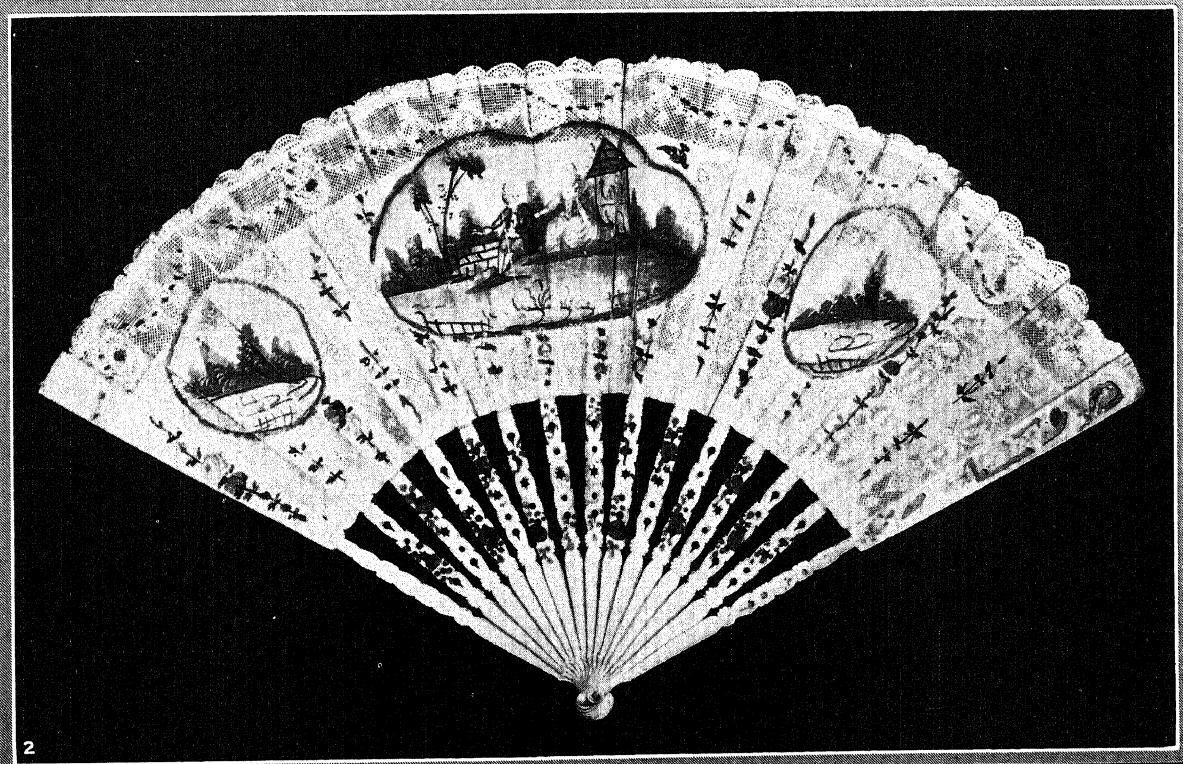
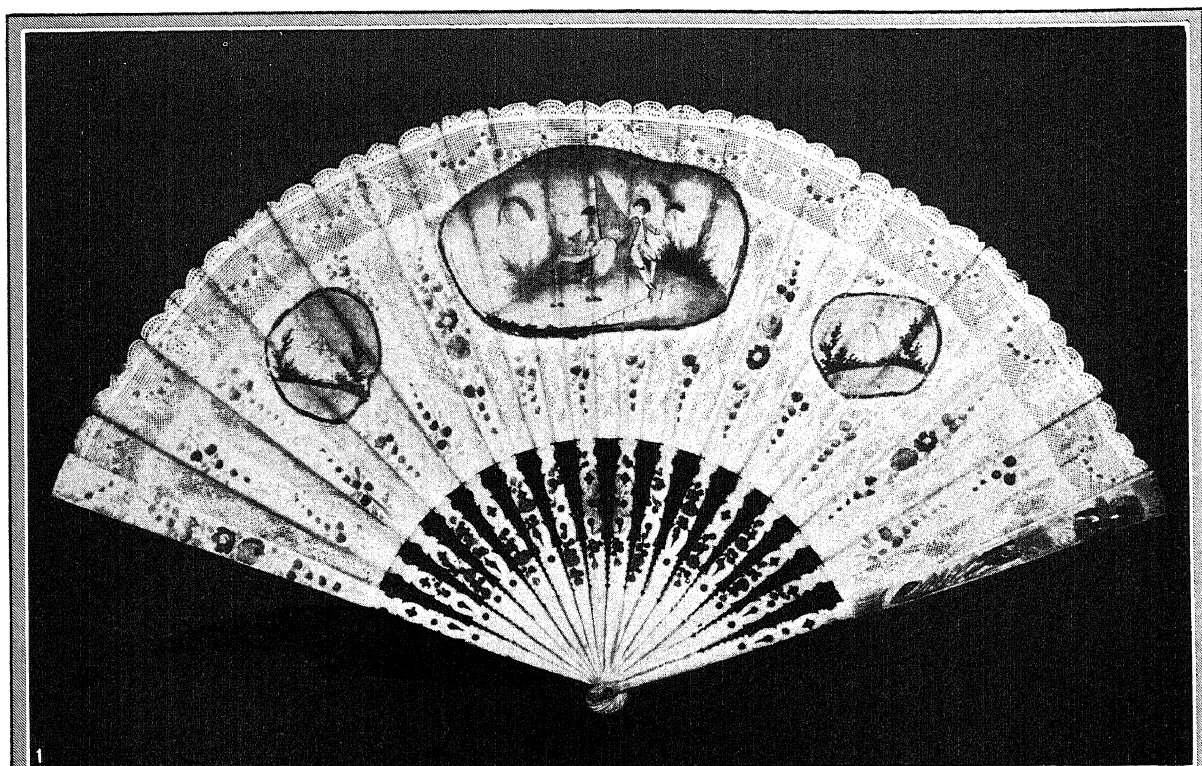


THE ART OF THE FAN MAKER

1. The "mystery fan," the panels of which are so decorated that reversing the position of the sticks produces different landscape scenes. 2. "The Dream of Napoleon," presented to the "Little Corporal" early in his career. 3. Japanese *brisé* fan work. 4. Carnival or "masque" fan.

PHOTOS BY N. LAZARNICK. FROM THE COLLECTION OF THE LATE DAVID BELASCO

FANS

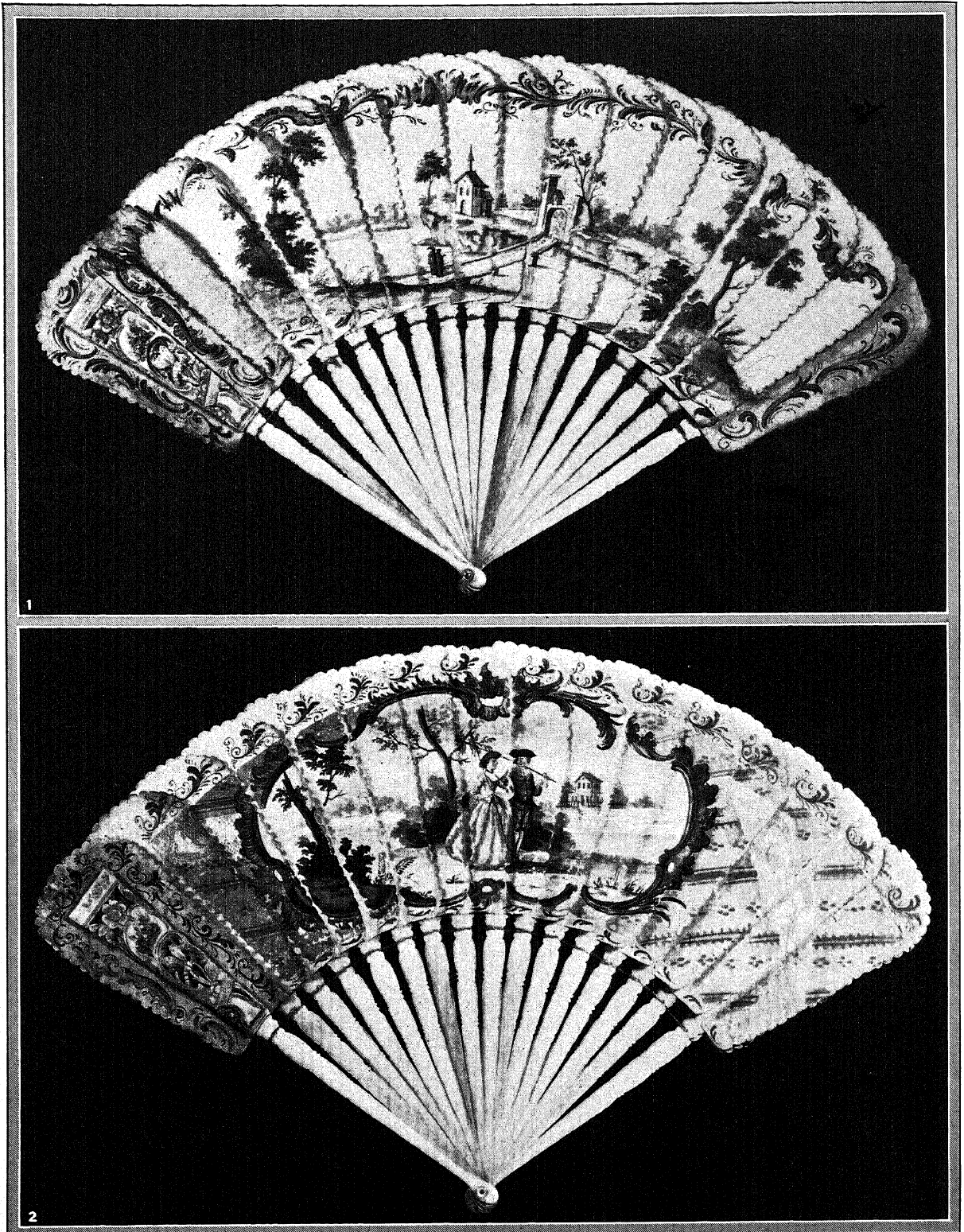


PHOTOS BY N. LAZARNICK, NEW YORK. FROM THE COLLECTION OF THE LATE DAVID BELASCO

AN EARLY FRENCH FAN

1. Ivory hand-painted, carved and gilded against a background of lace make up this exquisite fan.
2. Reverse of the fan in Figure 1, painted with the outdoor scenes typical of the period.

FANS



PHOTOS BY N. LAZARNICK, FROM THE COLLECTION OF THE LATE DAVID BELASCO

FRENCH FANS

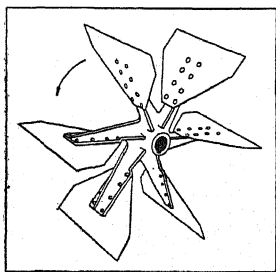
Two examples of fans of the time of Louis XIV. The panels of the fan are so decorated that by reversing the position of the sticks different scenes are produced.

to large and elaborate surfaces swayed like a screen or carried at one end of a richly decorated staff. In the delicacy of the workmanship shown in the painting and decoration, Oriental fans might be compared with the finest miniatures. Many Chinese fans were made entirely of ivory with low-relief or cut-out decoration; others of metal were inlaid with colored enamels.

In Europe fans came into vogue in the 16th century, and from this time on fan-making became one of the decorative arts in the Occidental world, the craftsman having his own guild and tradition. In 18th century France the vogue for fans reached its height, the possibilities for ingenious invention and decoration rapidly being exhausted. Cheap materials and poor workmanship later became apparent and marked the gradual decline of the fan as a distinctive symbol of taste and fashion.

FANS, power driven machines comprising open airscrews, or propellers, or enclosed rotating impellers which deliver air at varying velocities and pressures. The open, or propeller type, delivers large volumes of air against a small "head" or resistance, and is employed chiefly in ventilation. They vary in size from the small household fan to the mine-ventilating blowers requiring more than 1,000 horse power. They are usually driven by electric motors or steam turbines; they may have two or more radially balanced blades. Many later types use the AIR PROPELLER type of blade. Either the propeller or the centrifugal type of fan may be used to deliver a gas to or drag it from a space, such as a FURNACE, in which cases they are respectively termed forced-draft and induced-draft fans. Also, they may be used to deliver dust or other solid particles such as pulverized coal.

Where air is to be delivered into ducts or furnaces where the resistance is great and necessitates high pressure, the centrifugal fan or blower is usually employed. In the ordinary type of centrifugal fan (Fig. 1) the impeller comprises a hub with radial blades, but in the Sirocco centrifugal fan (Fig. 2) it comprises two rings between which a number of narrow radial blades are fastened, one of the rings being attached to a disc-like hub.



COURTESY AMERICAN BLOWER CORP.

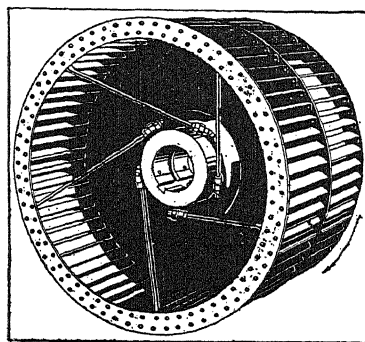
FIG. 1. IMPELLER ELEMENT OF CENTRIFUGAL FAN

Air-handling equipment is among the important auxiliaries of the modern high-rated stoker-fired and pulverized-fuel-fired boiler plants, and the selection of the proper type and size of this equipment has a decided bearing on the satisfactory operation of the plant.

For a stoker-fired boiler not more than two fans are required, a forced-draft fan and an induced-draft fan. For a pulverized-fuel-fired boiler three fans may be employed; a primary-air fan or feeder blower for de-

livering the fuel to the furnace, a secondary-air or forced-draft fan, and an induced-draft fan.

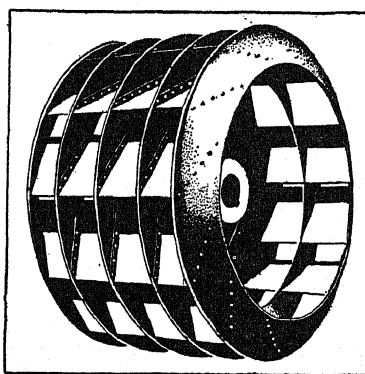
For forced-draft or secondary-air fans, the high-speed type of fan is commonly supplied where motor or turbine drives are used. This fan has a number of blades curved backward with respect to the direc-



COURTESY AMERICAN BLOWER CORP.

FIG. 2. IMPELLER OF SIROCCO CENTRIFUGAL FAN

tion of rotation (Fig. 3), and will not overload if the resistance of the system is decreased due to holes in the fire or other causes. Straight-blade and forward-curved-blade fans are sometimes used where low-



COURTESY AMERICAN BLOWER CO.

FIG. 3. HIGH SPEED FAN WHEEL FOR FORCED DRAFT WORK

speed engine drives are required. The function of the forced-draft fan is to furnish air to the fuel being burned.

For induced-draft fans the straight-blade and forward-curved-blade fans are most commonly used. Induced-draft fans for high-rated coal-fired plants are usually furnished with wearing plates on the blades and in the housing to resist the erosive action of the "fly" ash which passes through them. The function of the induced-draft fan is to remove from the furnace the air supplied for combustion and the gases generated in burning the fuel. Other applications of fans are found in heating and drying operations. See *also* VENTILATION.

E. W. L.; K. T.

FAN VAULT, a type of cut-stone vault invented and widely used in the English Perpendicular Gothic period, so-called from its decoration, which resembles a series of fan-like forms spreading out from each

support. In a fan vault each severy, or the section supported on a single pier, is conoidal in shape, rising and spreading equally in all directions from the pier, until it intersects walls or the next severies. It somewhat resembles a section of an inverted bell. At the summits the four-sided spaces left in each bay between the adjacent severies are bridged with a very flat vault or even a single slab.

The origin of the form is in the English love of complicated vault ribbing. The reduplication of ribs rising from a single pier tended more and more to take a conoidal shape. And eventually the number and complexity of the vault ribs became such that it was simpler to build the vault of homogeneous cut stone and carve ribs on its surface, than to cut separately the multitudinous individual ribs and stones for the small spaces left between. The earliest appearance of the true fan vault was in the east arcade of the cloister of Gloucester Cathedral, between 1357 and 1377. On a small scale, with painted ribs only, the type was used on the monument of Sir Hugh Despencer, in Tewkesbury Abbey, in 1349. The most remarkable examples are those of the chapel of King's College, in Cambridge, begun 1512, remarkable in its use of great cross ribs; and that of the Henry VIIth

Chapel in Westminster Abbey, begun 1502, where the conoids are supported on pendants dropped from huge cross arches whose lower parts appear as brackets, while the upper parts are hidden above the vault. See *GOthic ARCHITECTURE*.



SECTION OF FAN-VAULTED ROOF
OF CHAPEL OF HENRY
VII, WESTMINSTER ABBEY

FARAD, the practical unit of electrostatic capacity (see *CAPACITANCE*); that value of capacity which causes a charge of one coulomb to have a potential difference of one volt. When a **CONDENSER** is connected to a **BATTERY**, the condenser plates become charged. The amount of charge acquired depends upon the electromotive force of the battery and the capacity of the condenser. During the charging process the potential difference between the plates of the condenser increases, and eventually reaches a value equal to the electromotive force of the battery, when the flow of **ELECTRICITY** ceases and the charging process is completed. The charge acquired is given numerically by the product of the electromotive force and the capacity of the condenser.

The practical electrical units have been chosen to form a consistent system, so that numerical relations are used in the algebraic statements of electrical laws without the use of proportionality constants. The coulomb and volt having previously been determined, it follows that a condenser has unit capacity, if, when charged with one coulomb, there is, between its plates, a potential difference of one volt.

The farad is an extremely large unit, too large for convenient use in practical measurements. The microfarad, one-millionth of a farad, is a more convenient unit. For specifications and measurements of extremely small capacities, such as the capacities of the tuning condensers of **RADIO RECEIVERS**, the micro-microfarad, one-millionth of a microfarad, is sometimes used.

L. B. S.

FARADAY, MICHAEL (1791-1867), English physicist and chemist, was born at Newington, Surrey, Sept. 22, 1791. He became assistant to Sir Humphry Davy at the Royal Institution in 1813. In 1825 he was appointed director of the Royal Institution laboratory, and in 1833 was elected Fullerian professor for life. A chemist of note, the discoverer of benzene, and a pioneer in experiments on the liquefaction of gases, Faraday's fame rests chiefly on his researches in electricity. He discovered the principle of induction, electrostatic and electrodynamic, investigated the laws concerning electrolytic action and the decomposition of solutions by a current, and showed the influence of magnetic fields upon polarized light. He thus laid foundations for practical and industrial applications of electricity, and paved the way for the electromagnetic theory of **JAMES CLERK MAXWELL**. He died at Hampton Court, Aug. 25, 1867.

FARADAY EFFECT. See *MAGNETO-OPTICS*.

FARALLONES, a group of small islands situated approximately 30 mi. west of San Francisco, Cal., to which city they belong. They are known as the North, Middle and Southeast Farallones and lie almost parallel to the coast. The islands are rocky and are inhabited by sea gulls and murre, which formerly supplied quantities of eggs for the San Francisco markets. In 1909 the Federal government declared the Farallones a bird reservation. A lighthouse stands on the most southern island.

FARCE. Some authorities regard farce as an illegitimate form of dramatic art; others rightly insist that it be regarded as having a thoroughgoing claim as a legitimate form, even though it is a deviation from the normal of what the classic definer regards as **COMEDY**.

Prof. Brander Matthews, by catching at the essence of what critics like Ferdinand Brunetiere had written, drew attention to the fact that comedy and **TRAGEDY** allow character to control plot and situation; whereas in farce and melodrama, the opposite is true. Professor Matthews intimated that his popular definition could not be held rigidly accountable, since at times farce rises to the height of comedy, just as comedy often sinks to the level of farce. Truly, all that a definition can do is to give one the countenance of farce, and warn that even a countenance may have variable expressions.

The historical evidence of the presence of farce depends entirely on how clearly its characteristics are kept in mind. It can, of course, be taken immediately back to its phallic origin, born of the comedy toasts to the god of wine in the Greek religious festivals.

Exuberant ARISTOPHANES, with his lyric love of burlesque, might thus be hailed as the first farce writer. Apart from the internal evidence of the farce humor of PLAUTUS, the fact alone that he was the inspiration for Nicholas Udall's *Ralph Roister Doister*, for MOLIÈRE, who was regarded as the arch-French farce writer of the Grand Monarch's time, despite the bewailing of Boileau—and for Shakespeare's *Comedy of Errors* and *The Taming of the Shrew*, two plays which have all the ear-marks of farce upon them, is sufficient to place him in the category of farceur. No definition of farce could avoid calling in the merry situations in Molière and Shakespeare for illustration. The French designated the form as *basse comédie*. If both internal evidence and external influence entitle Plautus to a place in the delineation of farce, why not TERENCE, upon whom a large part of French and English drama leaned so palpably?

In the medieval history of the theater, farce, as Professor Schelling has pointed out, touched hands with minstrelsy, and, as an off-shoot of miracles and mysteries (see MYSTERY PLAYS), came the *sermon joyeux*, the *sottie*, the comedy of fools, and the song and dance of FOLK-DRAMA. The varying humors of farce are embroidered in the gay tapestry of the Italian *commedia dell' arte* (Duchartre: *The Italian Comedy*). The farcical scenes in the miracles and mysteries, the farce element in what is accounted the first English comedy, the story of Mak and the Sheep in the Towneley Second Shepherds' Play and in Noah's Flood, as well, the burlesque of the Roy Bishop and the Feast of Fools, may all be listed among the early examples of farce. So, too, one may characterize as farce John Heywood's *The Merry Play between Johan the Husbande, Tyb his Wife and Syr Jhan the Preest*, as well as his *The Four P's*. In medieval France, *Pathelin* is the typical farce type.

In the 18th and 19th centuries, the form became more defined as a stage amusement. Amidst a plethora of farces, David Garrick's *Lying Valet* and his *High Life Below Stairs*, stand out as the most famous in the stage history of this time. Among other farce writers of Garrick's generation were Robert Dodsley, Theophilus Cibber, Henry Fielding, Arthur Murphy, George Colman the younger, Samuel Foote and John O'Keefe.

In the history of the 19th century British theater, the distinctive farce writers were J. R. Planché, John Maddison Morton, H. J. Byron and F. C. Burnand. No historian of this period should neglect to mention that in 1874 the London Criterion Theater had a noteworthy career in farce, and that, in 1885, Arthur Wing Pinero started creating what were known as his Court farces. Of the London farces of the modern period, the two outstanding ones were *The Private Secretary*, 1884, by Hawtrey, and Brandon Thomas's *Charley's Aunt*, 1892. Recent times have seen, since 1922, the Aldwych Theater as the home of farce.

In American theater history the way is strewn with foreign adaptations of French and German farces like those produced by AUGUSTIN DALY and CHARLES

FROHMAN. But from the time that Charles Hoyt in the '80s produced his typically American farces, cartooning native fads and fancies, reflecting humorously native social quirks, the American playwright in such farces as *Seven Days*, *Officer 666* and *A Pair of Sixes* has tightened the technique of farce to some semblance of a special form. But the characteristics of farce remain the same: its intents and purposes are still within the scope of Professor Matthews' definition. What are these characteristics?

Farce is that form of comedy in which probabilities are freely disregarded for the sake of laughter. Mistakes of various kinds, which would be quickly rectified in real life, are not rectified until the final curtain, and supply enough fun to last two hours. Characterizations so exaggerated that they become caricatures are frequent. The audience concedes what the author wishes provided only that the result be ludicrous. It grants, therefore, that adult males cannot penetrate the disguise of one of their number who masquerades as a female (*Charley's Aunt*), that an enraged South-American who is such a remarkable shot that he strikes a bell-push across the room at his first attempt may nevertheless miss human targets at point-blank range immediately afterward (Georges Feydeau: *La Puce à l'Oreille*), that Russian terrorists may house their "archives" in the palace of the hostile governor, and detail one of their number to act as his body-guard (Leo Birinski: *Narrentanz*), that an interpreter whose knowledge of English is confined to the single word "Yes" may succeed in hoodwinking both his French countrymen and an English traveler (Tristan Bernard: *L'Anglais tel qu'on le parle*), and that the mustaches of the German emperor may possess the power of eloquent movement (G. B. Shaw: *The Inca of Perusalem*). In passing, mention should be made of the extremely artistic farces produced in the form of MOTION PICTURES by Charles Chaplin.

FARCY, a form of glanders which affects the skin and the lymphatics of one of the limbs, usually a hind quarter, caused by the *Bacillus mallei*. In farcy the limb affected is much swollen, often making movement almost impossible for the animal. The enlarged lymphatics appear under the skin as a string of hard, painful lumps. These so-called "farcy buds" soon form abscesses which break, discharging thick yellowish blood-stained pus. If they heal, they do so very slowly. Constitutional disturbances are similar to those of glanders. The afflicted animal should be destroyed. See GLANDERS.

FAR EAST, that part of Asia bordering on the Pacific and Indian Oceans, in which the principal countries are China, India and Japan.

FAREWELL-TO-SPRING (*Godetia amoena*), a slender branching annual of the evening-primrose family, called also summer's darling. It is found wild near the coast from California to British Columbia. The plant grows about a foot high with narrow leaves and satiny, lilac-crimson flowers, often 2 in. broad. Numerous double and variegated forms are cultivated in gardens.

FARGO, WILLIAM GEORGE (1818-1881), American expressman, was born at Pompey, N.Y., May 20, 1818. With Henry Wells he organized in 1844 an express company to operate between Buffalo



FROM JEPSON, MAN. FL. PLANTS CALIF., COPYRIGHT

FAREWELL-TO-SPRING

and western points. In 1850 this company, after operating under various names, became the American Express Co. He was president of the new company from 1868 to 1881. He served as mayor of Buffalo from 1862 to 1866, dying there Aug. 3, 1881.

FARGO, a city on the eastern boundary of North Dakota, the county seat of Cass Co., situated on the Red River opposite Moorhead, Minn. Bus and truck lines and three railroads afford transportation. There is an airport. The region is known as the Bread Basket of the World because of its wheat. Fargo is a market for farm ma-

chinery, and has flour mills, packing houses and various factories. In 1929 the manufactures reached an approximate total of \$7,000,000; the retail trade amounted to \$21,693,129. It is the seat of the North Dakota Agricultural College and a branch of the Agricultural Experiment Station. Fargo was permanently settled in 1873; chartered in 1875. Pop. 1920, 21,961; 1930, 28,619.

FARIBAULT, a city in southeastern Minnesota, the county seat of Rice Co., situated at the confluence of the Cannon and Straight rivers, 50 mi. south of St. Paul. Bus and truck lines and four railroads make the city a shipping point for dairy produce and live stock. Faribault is a manufacturing center for woolen goods, floor trucks, shoes, furniture, beverages and flour. It has also nurseries, canneries and packing houses. In 1929 the manufactures were valued approximately at \$5,000,000; the retail trade amounted to \$6,370,395. The city is the seat of Shattuck (Military) School, St. James School, St. Mary's School and Seabury Divinity School, an Episcopal institution founded in 1858, and the Catholic Bethlehem Academy. The state institutions for the blind, deaf and feeble-minded are located here. Faribault was founded about 1826 and incorporated in 1872. LeCivix, a miller, revolutionized the process of making flour here in 1860. Pop. 1920, 11,089; 1930, 12,767.

FARID UD-DIN ATTAR (1119-1230), Persian poet and philosopher, whose real name was Abu Hamid Mohammed ben Ibrahim, was born at Shadyakh, Nishapur, Nov. 1119. Farid was a dealer in perfumes, which accounts for the significance of his name, *Pearl of the Faith, Druggist*. He studied Sufic philosophy and followed the footsteps of Jalal ud-Din. A

prolific writer, his masterpiece is conceded to be the allegorical *Parliament of Birds*, a poetical parable of the soul on its dangerous journey towards mystic illumination and divine union. Author of 40 poems and several prose works, besides a *diwan* containing 40,000 verses, Farid retired from the world and outlived the century mark. He was slain in a mongol massacre, Apr. 26, 1230.

FARIGOULE, LOUIS. See ROMAINS, JULES.

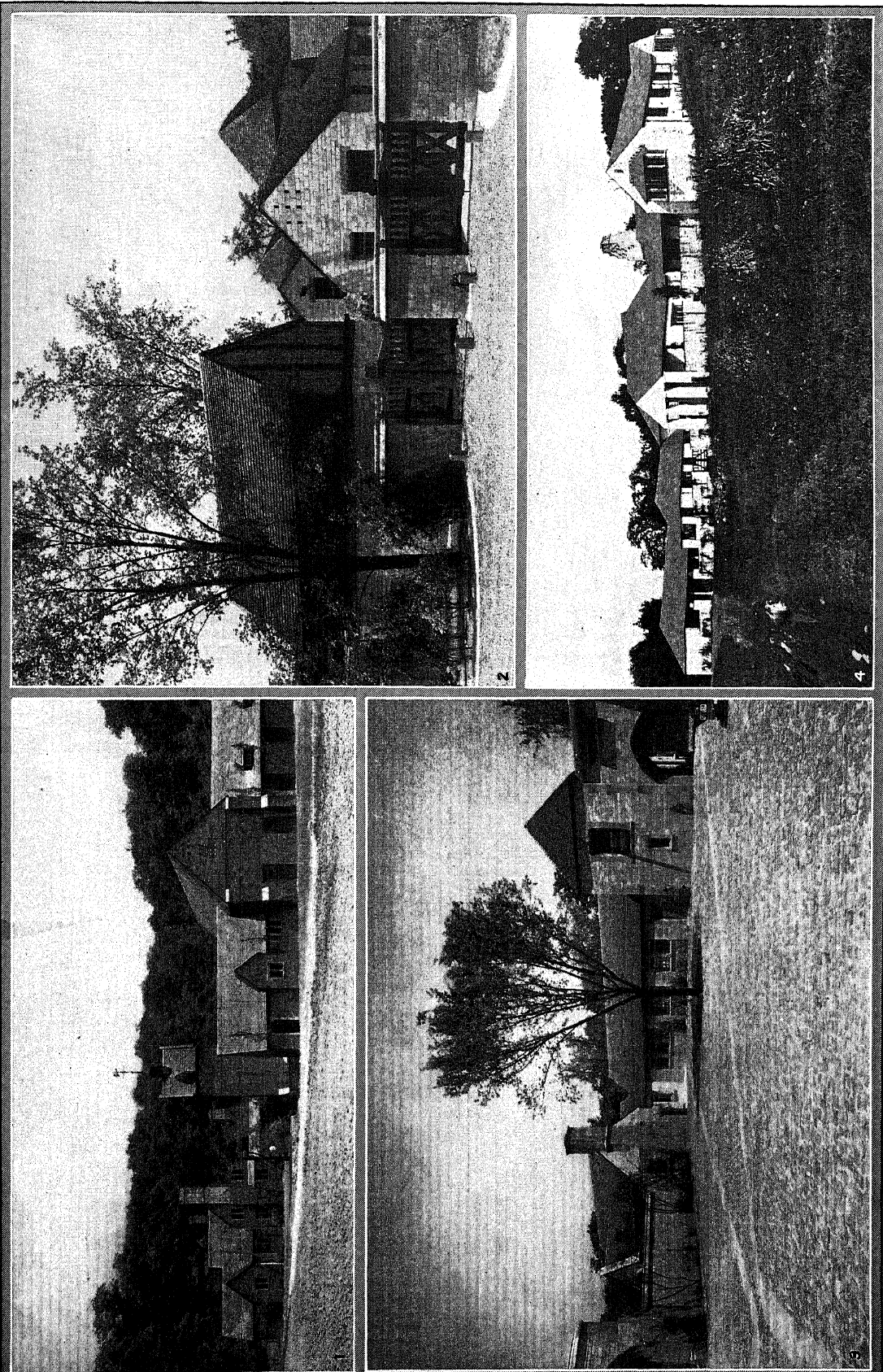
FARLEY, JOHN MURPHY (1842-1918), American cardinal, was born at Newton Hamilton, County Armagh, Ireland, Apr. 20, 1842. He came to the United States in 1859, attended St. John's College (now Fordham University), Fordham, N.Y., St. Joseph's Seminary, Troy, and then the American College, Rome. Later at Rome, he was ordained, and after two short pastorates in New York, he served from 1872 to 1884 as secretary to Archbishop McCloskey, and in 1892 became a domestic prelate to Pope Leo XIII. Ten years later he was made the fourth Archbishop of New York, and while Archbishop he organized the hundredth anniversary of the New York diocese, and the consecration of his cathedral. In 1911 he was made a cardinal. He encouraged the annual retreat of priests, and was particularly active in looking after the welfare of the people in his diocese. Cardinal Farley was the author of *Life of Cardinal McCloskey* and the *History of St. Patrick's Cathedral*, and was active in bringing about the publication of the *Catholic Encyclopedia*. He died in New York, Sept. 17, 1918.

FARMAN, HENRY (1874-), French aviator and airplane manufacturer, was born at Paris, May 26, 1874. In 1907 he made design changes in a Voisin biplane, and in 1908 was awarded the Deutsch-Archdeacon prize for the first plane to fly one kilometer in a complete circle. The following year he attracted international notice by a record flight of 111.8 miles in 3 hours, 4 minutes, 56½ seconds. In recognition of this feat Farman was made a chevalier of the Legion of Honor. Farman soon afterward opened airplane factories at Billancourt, supplying machines to several European governments. Farman was the second aviator in Europe to fly in a heavier than air machine. He established new world records for flight duration and height in 1920.

FARM BOARD. See FEDERAL FARM BOARD.

FARM BUILDINGS. The habitations of animals have from time to time been given a fine architectural treatment, though this is true more particularly of the stable for the hunter and the horse fancier, as the hunting stables of England and France attest. The farm building has more frequently been treated as a thing of a stricter utility. Account is seldom taken of the very charming effect of the long low lines of sheds and stables, the more lofty and dominating masses of structure needed for the storage of hay and grain, and the tall towers for the modern way of caring for water and ensilage. Many picturesque farm groups in New England, Pennsylvania and the

FARM BUILDINGS



MODERN FARM BUILDINGS IN THE UNITED STATES

1. Stone farm buildings for John W. Lawrence, at Darceyville, Pennsylvania. 2. Compact farm building group for H. N. Strauss, at Red Bank, New Jersey.
3. Rear view of No. 2, showing the corn crib and gate to bull yard. 4. Farm building plan for Walter Douglass, near Dobbs Ferry, New York.

Middle West bear witness to this natural beauty. In their normal requirements the architect has in the farm group all the material he needs for every variety of architectural expression. Practicability and artistic quality in building may be joined if it lies in the spirit of the artist to so combine them to fulfill both purposes.

The modern farm building is very different in its structure from the earlier one. During the last two or three decades the bacteriologist has played an important part in its design. Milk production has been modified by the bacteria count. The modern cow barn and dairy is the exact duplicate of the modern hospital and operating room. Indeed the task performed in each is identical: that of protecting vulnerable fluids from infection; of avoiding their contamination by bacteria found on particles of matter so light as to float in the air. Consequently, the modern cow barn starts from a viewpoint of strict sanitation. Its walls, floors and ceiling must be of material impervious to absorption. Many and large windows are desirable so that the floors may receive the benefit of drying, purifying sunshine. The old wooden stanchions are replaced by those of metal; the former straw bedding by the sterile planer shavings; the casual, congregate watering trough, by individual drinking cups. All feed is kept as far away from milk production as is consistent with reasonable convenience. The chances of infecting the product by the dust of the stable are made remote, both by the manner in which the building is designed and constructed and the careful attention given to keeping it clean.

The simplest materials are the best, and for that practicability insisted upon, a wood structure for the cattle is generally better than a masonry one, particularly in winter. Masonry is cold in that season, and it is difficult to use artificial heat wisely. Likewise a too great cubic content per animal makes a cold barn. Five hundred cubic feet per capita is ample. For the young stock wing less than this is better but frequently unpractical. Artificial heat is more desirable here, but it must be used with caution. Therefore, the buildings are best grouped to form a protected enclosure for cattle and the cattle barns. In this grouping the practical and the artistic are now combined, for southern courts are the most suitable for the stock, and the play of sunshine and shadow there, the sheltered walls for growing vines and spreading trees provide for the architect his most effective setting. *See also* BARNs; DAIRY BARNs; FARM HOUSEs; HOG HOUSEs; ICE HOUSEs; IMPLEMENT SHELTERS; POULTRY HOUSEs; SILOS. A. H.

FARM EQUIPMENT MANUFACTURE, UNITED STATES. The statistics from the Bureau of the Census, presented in the following table, cover for 1929 the production and sale at manufacturers' prices, both for use within the country and for export, of all classes of implements, tools and other equipment used either exclusively or to a large extent on farms.

FARM EQUIPMENT MANUFACTURE, 1929

Class	Total manu- factured \$	Sold by Manufacturers	
		For use in U.S. \$	For export \$
Plows and listers ..	42,365,129	30,450,213	8,920,618
Harrow, rollers, and stalk cutters ..	16,813,081	13,399,536	2,445,065
Planting and fertiliz- ing mach'y ..	31,145,092	24,811,493	3,689,795
Cultivators and weed- ers	22,856,855	20,536,408	1,126,102
Harvesting machinery	87,712,968	53,655,787	20,580,151
Haying machinery ..	18,711,607	17,310,924	1,786,986
Threshers and other crop-preparation mach'y	30,103,384	24,824,844	3,160,567
Tractors ..	227,632,527	155,406,163	59,314,691
Horse-drawn vehicles	8,813,307	8,194,073	580,357
Barn and barnyard equipment ..	10,269,150	10,019,855	37,002
Pumps, windmills, si- los, etc.	110,640,505	99,911,768	11,229,121
Total, all classes ..	607,063,605	458,521,064	112,870,455

FARMER, one who raises foodstuffs or industrial crops for market. He may learn his business through careful scientific training in an agricultural school or college or through the apprenticeship of a farm boyhood. He should enjoy life in the open air, hard manual work and the comparative solitude of a rural district. He should possess also enough sportsmanship or philosophy to see his most promising crop laid low by storm or devastated by insect pests without giving up.

Modern developments have made the farmer's life at once more simple and more complex. Advice of experts is easily at his disposal through county, state and federal agricultural agencies, government bulletins and through radio broadcasts from state colleges and farm bureaus. The recent substitution of the internal combustion engine for the horse, enables him to cultivate his acres with greater economy and efficiency. These same developments tend to eliminate the farmer who does not respond to new ideas and procedures. A further complication in the life of the modern farmer is the broadening of his market. Instead of raising wheat, corn, potatoes, hogs, cotton, flax, etc., to sell to his neighbors in a ten-mile radius, he must look for his buyers to distant urban centers and even foreign markets thousands of miles away. Therefore, he is forced to join with other farmers in farm associations or cooperatives in the interest of more effective marketing. R. PL.

FARM HOUSES. Certain requirements are recognized as necessary to fit a house to the needs of farm life. These ideals are seldom met, for too often the design and arrangement are dictated by limited funds.

The kitchen is one of the most important rooms and should be given first consideration in regard to location, light, ventilation and space for equipment. It should be readily accessible to all parts of the house, rear entrance, cellar steps, supplies, work porch, garden, clothes yard and poultry house, and it should be provided with a means for securing water without

going from under cover. The rear entrance should be provided with facilities for storing wraps, for cleaning the shoes and brushing the clothes and for washing the face and hands, eliminating the necessity for passing through the kitchen. Ample space is needed to store provisions, fuel and dairy products. The latter should not be kept in the same room as vegetables. Frequently, a building near the kitchen is provided, while a cellar built above ground near the rear of the house is the ideal storage place for root crops and apples.

A bath or toilet on the first floor is a convenience; it should be accessible from all parts of the house, and entered from a hall. Whether all rooms are on the ground floor or not is a matter of preference. A room on the first floor that can be used for an office and in case of sickness, as a bedroom, is a boon to the busy housewife. If all the bedrooms are on the second floor, both front and back stairs should be provided.

The dining room should open directly into the kitchen without intervening pantries. A large living room is needed for social functions; a fireplace in this room adds much to its comfort. There should be a vestibule or hall at the front door to eliminate the necessity for carrying wraps into the living room.

A room equipped as a laundry is a great convenience as it permits of a smaller kitchen and provides storage for equipment not in daily use.

Running water is the most essential of conveniences, while electricity for light, washing, and ironing is next. A central heating system is desirable, but the smaller houses are generally heated with stoves or furnaces.

T. A. H. M.

FARM RELIEF. Immediately following the World War prices of agricultural products in the United States fell more quickly and farther than did urban wages and retail prices. Farmers had developed an expanded program of cash expenditures, including heavy commitments for INTEREST and principal on land purchases, higher taxes, higher expenses for farm supplies and labor. This changed price situation produced foreclosures, forced sales and bankruptcies in many sections and severe declines in the values of farmers' equities in land nearly everywhere.

Numerous proposals, mostly legislative, have been made for the alleviation of these distress conditions. To these the term farm relief has come to be applied. The principal proposals have been: 1, The improvement of credit facilities available to farmers; 2, The fixing of agricultural prices by government action; 3, Various forms of governmental control directed at securing higher domestic prices for export products than those prevailing in the world markets; 4, Increase of tariff duties (*see* CUSTOMS DUTIES) on agricultural products; 5, An intensified program of cooperative activity directed at better organization of agricultural production and marketing; 6, an intensified program of investigation and education in the economics of agricultural production, marketing, and prices.

The first of these was for the most part embodied

in the Agricultural Credits Act of 1923. The second gained brief popularity in 1921, but did not receive serious consideration in Congress. The third has been the focus of bitter congressional fights since 1924, failing of enactment only through presidential vetoes, and is still a live issue. The fourth led to the tariff revisions embodied in the Hawley-Smoot Act of 1930. The fifth took the form of the Agricultural Marketing Act of 1929, under which the Federal Farm Board was set up. The sixth has been largely responsible for the Purnell Act of 1925, providing additional funds for the state agricultural experiment stations, and for considerable expansion in the economic investigations of the UNITED STATES DEPARTMENT OF AGRICULTURE. *See also* McNARY HAUGEN PLAN. J. D. B.

FARM RENTS. When a tenant pays rent to the owner of a farm he pays for the use of the land and its improvements, besides a charge for risks run by the owner. Rent is usually paid for the period of a year. The methods of renting prevalent in the United States are share, cash and stock share. Approximately three-fourths of the farm tenants of the United States rent their farms and lands on the share or share-cash basis. A share renter pays the owners a fixed share of the harvested crops, as perhaps one-half, or one-third. A cash renter pays the landlord usually at a rate per acre, as \$3, \$5 or some other amount.

In the case of share renting, predominant in most sections of the United States, the landlord oversees rather closely the farm work, and provides supplies or capital for farm operations. In the case of immature or inefficient tenants, the landlord gains a rent-rate advantage through these contributions. In the case of cash rent, second in frequency in New York, Pennsylvania, the North Central, Rocky Mountain and Pacific States, the landlord usually pays the taxes and upkeep.

In renting livestock farms the stock share lease is popular. It provides common ownership of cattle or milk stock, with lease for two to five years. It is usual for the tenant to furnish labor and equipment; the owner, land and buildings; while the owner and tenant share equally the farm income. Besides the foregoing there are standing rent, calling for payment in a specified amount of produce; croppers, providing only labor and paying rent by share of crop; fixed rents, requiring a rent rate fixed by custom, common in some parts of Europe, and share-cost rent, contracting for payment of cash for pasture, and share rent for harvested crops.

O. S. M.

BIBLIOGRAPHY.—C. L. Holmes, *Economics of Farm Organization*; L. C. Gray, *Introduction to Agricultural Economics*.

FARM VALUATION. Capitalized income is the usual method used for obtaining farm values in such countries as England and Japan. In the United States valuation is fixed by the market value or recent bona fide sales of farms in the locality of the farm in question.

Of first importance on either approach is the earn-

ing power of the farm. Location, climate, topography, surface and sub-surface soil conditions, farm enterprises, rotation, roads and neighbors are among the chief influencing factors. Earning power is further greatly influenced by the operator's managerial ability, by the command exercised over labor, crops, livestock, machinery, fields and fertilizers.

The location of the farm as to transportation facilities, communities, schools and markets, counts heavily in evaluating farms. Farms near a city are likely to be relatively high in value, stable in price, and therefore safe investments for farmer or landlord, due largely to low transportation charges, proximity to steady markets and future income.

The quality of soil is of practical importance. A group of 68 clay soil farms in Oregon brought 4.35% on their capital investment, whereas 144 silt soil farms brought 6.64% on capital. Of 10,000 farm mortgage foreclosures in New York, there was seven times the rate of foreclosure on farms with plow land valued at less than \$55 an acre, as on farms with plow land valued at \$195 or more. POPULATION trend, taxes, level of living, relative prosperity of country and city industries, tariffs, BUSINESS CYCLES, national and international policies also influence farm valuations.

O. S. M.

BIBLIOGRAPHY.—H. C. Taylor, *Outlines of Agricultural Economics*; U.S. Dept. of Agriculture, Circular 150, *The Real Estate Situation*.

FARNESE PALACE, considered a leading example of Renaissance architecture, is a small quadrangular two-storied building in Rome. Built in 1509-11 for the papal banker, Agostino Chigi, it was acquired in 1580 by Cardinal Alessandro Farnese and remained in the possession of his family till 1731. The kings of Naples held the villa until 1861, when it passed to the Duke of Ripalda. The ceiling of the entrance hall is decorated with Raphael's designs, 12 in number, of the myth of Psyche as told by Apuleius. In another apartment is Raphael's painting, executed in 1514, of Galatea borne across the sea in a shell. In other halls the work of 16th century Italian artists carry out the mythological idea, chief among them being the frescoes of Sebastiano del Piombo and Baldassare Peruzzi.

FARNHAM, a market town in Surrey, southeastern England. It is situated on the left bank of the Wey; London lies 35 mi. to the northeast. The electric power plant and the water-works are owned by the town. Hops are grown in the vicinity and afford the leading industry. There is a grammar school and a school for art and science. The town contains an old castle of the bishops of Winchester, destroyed by Henry III, and reconstructed by Charles I. Pop. (of district and town) 1921, 16,717; 1931, 18,294.

FARNOL, JOHN JEFFREY (1878-), English novelist, was born in England, Feb. 10, 1878. He was educated privately and began writing at 19. From 1902-10 he lived in New York City, where many of his early stories first appeared. Farnol's works, many

of which are historical romances of Kent, include *The Broad Highway*, *The Amateur Gentleman*, *Black Bartlemy's Treasure*, 1920, *The Loring Mystery*, 1925, *The Shadow*, 1929, and *A Jade of Destiny*, 1931.

FARO, a gambling game the name of which is taken from one of the court cards in old French packs on which a picture of Pharaoh appeared. The game then called Pharon, was popular in the court of Louis XIV. Faro was the favorite gambling game in the western United States in the early gold-mining days.

A full pack is placed face up in a dealing box. The top card is called "soda"; the last card in the box is said to be "in hoc." Before the dealer is a layout, a full suit of spades painted on the table in two rows. The upper consists of King, Queen, Jack, ten, nine and eight; the lower of one, two, three, four, five and six. The seven is placed between the rows, or, in some games, omitted.

The player bets on the order in which a certain card will be drawn from the box, placing his money on the corresponding card of the layout. A bet placed squarely on a card means that the card will win when turned. A "copper" (one cent) on a card means it will lose. Bets may be placed in 21 ways in all: between two cards, behind three, on the corners of four and so on. If any card of the combination shows in the winning pile, the bet is won or lost. After all bets have been placed, the dealer draws a card, placing it on one side of the box; then draws a second, placing it on the other side. If the card on which the player bet turns up in one pile, he wins, if in the other, he loses. If a card of the same denomination turns up in both piles, it is a "split," and the dealer collects half the bet.

To follow cards already dealt, the player may "keep cases" by means of a "case box," a rack on which are wires strung with buttons, something like an abacus. Or he may use "cue cards," on which a record is kept with a pencil.

See J. Debrete, *Faro and Rouge et Noir*, 1793, or any standard edition of *Hoyle's Games*.

FARO, capital of the former province of Algarve, now of the district of Faro, is the southernmost city in Portugal on the south coast near the Gabo de Santa Maria. It is situated on a bay teeming with sardines, and has an unhealthy climate. The town is badly built but it is the seat of a bishop and has an old cathedral, a monastery, lyceum, nautical school and nautical and archaeological museum. On an eminence stands the Church of San Antonio do Alto. From the large, shallow harbor agricultural products are exported. Pop. 1920, 12,925.

FAROE ISLANDS, a group of Danish islands located in the north Atlantic Ocean, lying between the Shetlands and Iceland, consisting of 21 islands and embracing an area of 540 sq. mi. The largest islands are Stromo, Sando, Ostero, Sadero, Bordo and Vago. The soil is not adapted to agriculture, the cultivated portion comprising only about 3% of the total area. Nearly half the population is engaged in fishing and livestock breeding. Woolen goods, lamb skins, tal-

low, fish and feathers are exported. Situated on Stromo Island, Thorshavn is the chief town and capital of the group, constituting the county of Denmark. Pop. 1930, 24,200.

FARQUHAR, GEORGE (1678-1707), English dramatist, was born in Londonderry, Ireland, in 1678, and studied briefly at Trinity College, Dublin. He went to London in 1697 and obtained a commission as lieutenant. At 20 his *Love and a Bottle* was produced with great success at Drury Lane, followed by *The Constant Couple*, 1700, *Sir Harry Wildair*, 1701, *The Inconstant*, 1703, from Fletcher's *Wild Goose Chase*; *The Stage Coach*, 1704, *The Twin Rivals*, 1705, *The Recruiting Officer*, 1706, and *The Beaux' Stratagem*, 1707. The last two are his masterpieces, and *The Recruiting Officer* has seen many revivals, including Daly's, 1885, with Ada Rehan as Sylvia and John Drew as Captain Plume. Farquhar was stricken when the play was being written, and finished it in six weeks to fulfil his obligation. It had attained its third night when the author died, Apr. 29, 1707.

FARRAGUT, DAVID GLASGOW (1801-70), American admiral, was born near Knoxville, Tenn., on July 5, 1801. He joined the navy at the age of 9, was engaged in battle in a position of responsibility at 12, but carrying on his studies assiduously, became by the age of 20 an accomplished scholar and linguist. In 1841 he was made commander, and was active in the war with Mexico. When Tennessee seceded, he moved to New York state. In 1861 he was assigned to the Gulf blockading fleet. In 1862 he defeated a Confederate fleet at New Orleans. He held the mastery of the Mississippi in 1863, aiding greatly in Grant's capture of Vicksburg. In 1864 he won the great battle of Mobile Bay, in which—with his famous "Damn the torpedoes! Go ahead!"—he destroyed the enemy's fleet in the face of imminent disaster. Ill-health forced his retirement from active service, but having been made rear-admiral in 1862 and vice-admiral in 1864, he was appointed an admiral in 1866. He died at Portsmouth, N.H., on Aug. 14, 1870.

FARRAND, LIVINGSTON (1867-), American educator, was born in Newark, N.J., June 14, 1867. He studied at Princeton, Columbia, Cambridge, England and Berlin. In 1893 he joined the faculty of Columbia University, where in 1903 he became professor of anthropology. From 1914-19 he was president of Colorado University and from 1919-21 chairman of the American Red Cross Central Committee. He became president of Cornell University in 1921.

FARRAND, MAX (1869-), American educator, was born in Newark, N.J., Mar. 29, 1869. He was educated at Princeton, Leipzig and Heidelberg. Farrand was professor of history at Stanford from 1901-08 and at Yale from 1908-25. In 1927 he became director of research at the Huntington Library and Art Gallery, San Marino, Cal. His historical works include *Records of the Federal Convention of 1787*, 1911; *Development of the United States*, 1918, and *Fathers of the Constitution*, 1921.

FARRAR, FREDERIC WILLIAM (1831-1903), English divine, was born Aug. 7, 1831, at Bombay, India, where his father was a missionary. He was educated at King's College, London, and Trinity College, Cambridge, where he became a fellow in 1856. He was assistant master at Marlborough College and Harrow, and then headmaster at Marlborough. In his career as a divine he became canon of Westminster, archdeacon of Westminster, and dean of Canterbury. His best known book is the *Life of Christ*, published in 1874. Other writings are, *The Life and Works of St. Paul* and *The Early Days of Christianity*. He died at Canterbury, Mar. 22, 1903.

FARRAR, GERALDINE (1882-), American soprano singer, was born at Melrose, Mass., Feb. 28, 1882. She began singing instruction at Boston when 12 years of age. She studied at Paris with Trabedello, and at Berlin with Lilli Lehmann. Her operatic début occurred in 1901 in the rôle of Marguerite at the Berlin Royal Opera, where she sang for three years, also appearing at Stockholm, Warsaw, Monte Carlo, and the Opéra-Comique, Paris. Her American début took place in 1906 at the Metropolitan Opera, New York, singing in Gounod's *Juliette*. She remained with the Metropolitan Opera until 1922. In her large repertory her best parts were as Madame Butterfly, Tosca and Carmen.

FARRELL, JAMES AUGUSTINE (1863-), president of the United States Steel Corporation, was born in New Haven, Conn., Feb. 15, 1863. He became foreign sales agent of the United States Steel Corporation in 1901 and two years later president of the United States Steel Products Export Company. In 1911 he became president of the United States Steel Corporation and was one of the chief witnesses for the defense in the suit in 1913 brought by the United States against the corporation. In 1932 Farrell retired from the presidency of the company.

FARRELL, a city of Mercer Co., northwestern Pennsylvania, situated on the Shenango River, immediately south of Sharon. It is a railroad center, served by five lines. Farming and dairying are the leading interests of the countryside. The chief local manufactures include steel and iron products, wire, tin plate and castings. The retail trade in 1929 amounted to \$3,916,645. Farrell was incorporated in 1901, and became a city of the third class Jan. 1, 1932. Pop. 1920, 15,586; 1930, 14,359.

FARSIGHTEDNESS. See AMETROPIA.

FARTHING, a small bronze British coin, four of which are equivalent to a penny. It is legal tender up to sixpence. When the farthing was introduced in the 13th century it was of silver, but from the 17th to the 19th century it was struck in copper.

FARUKHABAD, a city and district in the Agra division of the United Provinces, British India. The city, which forms a joint municipality with Fatehgarh (a British possession since 1803 and the civil headquarters of the district), contains the government gun-carriage factory and manufactures gold lace, printed cotton cloth and tents. The district of Farukhabad

is an alluvial plain watered by the rivers Ganges, Arind, Isan and Kali-Nadi. It produces rice, cotton, millet, sugar and tobacco. Area 1,683 sq. mi. Pop. 1921, city, 48,331; district, 856,633; 1931, district, 877,589.

FASCES, in ancient Rome, a bundle of rods in which an ax, with blade protruding, was bound up with a red cord, carried by *LICTORS* before magistrates, with *IMPERIUM*, while in the performance of their duties. The rods typified civil power, and the ax, *imperium*, or the power of life and death. The ax was not carried within one mile of the city.

FASCINES, round bundles of brush and twigs bound together and cut to convenient length for use as revetment for parapets or walls. Also used in mattress construction for strengthening soft or wet spots in roads. Their main use is in retaining wall construction in field fortifications.

FASCISM, the term applied to a political movement initiated in 1919 by Benito Mussolini in Italy and to the theoretical expression of this movement in the political system that has evolved since the accession of the Italian Fascists to power. Fascism is one of the contemporary challenges to the system of Parliamentarism. The derivation of the term indicates the arbitrary unity impressed upon the divergent elements that go to make up a political state. The old Roman *fascis* was a bundle of rods with an axe bound in with them with the blade projecting. It was borne in procession before Roman magistrates as a symbol of their power over life and body. Similarly, Mussolini during the World War had laid the foundations of an organization which constituted a *fascio* or bundle of divergent groups from the various bourgeois anti-Socialist and strongly nationalist elements that had lost confidence in the old Parliamentary scheme of things. Although this Fascist organization of Mussolini was defeated in the election of 1919, the Communistic uprisings and the occupation of the factories in 1920 as well as the weakness of the Socialist and the Liberal parties in power gave Mussolini the opportunity of forging a mighty organization.

After a violent campaign against the Socialists throughout Italy an army of Italian Fascists led by Mussolini marched to Rome Oct. 26, 1922 and forced the King to call upon Mussolini to form a new Cabinet. At first Mussolini governed as practical dictator under a grant of plenary power obtained from the first Fascist ministry. In Nov. 1923 a new bill was passed which gave the excuse for the elections of Apr. 1924. By the exercise of violence and coercion as well as good will, the Fascists obtained 65 per cent of the votes cast. Opposition was thus swept away, and Parliament became merely a means of registering the decisions of the inner group of the Grand Fascist Council. In June 1925 Mussolini obtained the power to dismiss civil servants and to issue decrees with the force of law. The activities of the National Militia and the suppression of the freedom of the press were instrumental in reducing opposition. The members of the party are organized on a military basis and

are known as Black Shirts. Through these legal and extra-legal aids, consequently, the nation is forced to live up to the Fascist ideal of unity. Classes, groups and factions as well as individuals are under compulsory obligation to heed the various Fascist decrees and to be actuated by the Fascist maxims of Self-discipline and Responsibility, Self-sacrifice and Duty. "The Charter of Labor" of 1927 states the principles of the Fascist State and of its political and economic program. "The Italian Nation," it says, "is an organism whose aim, whose life and whose means of action are superior to those of the single individuals occupying and forming it." X.

Economics of Fascism. The almost continuous crisis that took place in Italy after the advent of Fascism in 1922, made it necessary for the Fascists to drop their early policy of *LAISSEZ FAIRE* and to intervene in the economic life of the country. In 1925 when the lira was falling, the labor elements of the Fascist Party under the leadership of Edmondo Rossoni took advantage of the situation to demand better working conditions. Strikes became so numerous that there was danger of a return to the anarchical conditions of 1919-20 and the disruption of the Fascist Party. In order to maintain social peace, strikes and lockouts were prohibited and the machinery of the corporate state, with its labor courts, was set up.

Under its auspices 172 national and 5,721 provincial collective contracts were negotiated to 1930 and through them Fascist authority was exerted on both capital and labor. Then because of bad times the corporate state gradually took on other functions than those of settling labor disputes and developed into an organization to plan and regulate the economic life of Italy (*see FIVE YEAR PLAN*). The Ministry of Corporations succeeded to most of the duties of the Ministry of National Economy in 1929, the National Council of Corporations composed of delegates of all the confederations was established in 1930 as a supreme economic body, an export institute was established under the Ministry of Corporations to stimulate exports, and the employers' confederation developed more and more into technical trade associations.

The development of this machinery was accompanied by the growth of a definite economic theory and by the realization of concrete accomplishments. For the theory one should consult the Labor Charter of 1927, which states that the welfare of the state is superior to the welfare of the individual; that labor in all its forms is a social duty, because production is the basis of national economic strength and welfare; that private initiative is preferable to state socialism; and that the state must control and plan the production of the nation by means of the corporate system. Concerning the economic accomplishments of Fascism one should notice its endeavors in the fields of agriculture, industry, and commerce. In agriculture a Battle of the Grain was instituted for the purpose of increasing the production of wheat. Farmers were instructed in the most efficient methods of cultivation and were spurred on by popular propaganda.

As a result production increased from an average of 10.4 quintals per hectare in the period 1909-14 to 12.7 for the period of 1927-29. There was also undertaken a large program for land reclamation that was to affect about 3,823,000 hectares. In the field of industry Fascists encouraged infant and key industries by subsidies (for 1929-30, 74,500,000 lira for civil aviation, 34,000,000 lira for merchant marine construction, and 226,000,000 lira for merchant marine services), by a protective tariff on the goods themselves and a low tariff on machinery for their production, and by the subsidizing of industrial research experts. In the field of commerce facilities of transportation were improved, the tariff on competitive articles was raised about 17% ad valorem but reduced by reciprocity agreements to admit raw materials; preferential railway rates of 15% were given on goods destined for export; and the Export Institute was set up to combine the efforts of exporters and to manage state export credit insurance. These measures admittedly had some influence on the foreign commerce trade figures which were:

Imports	Exports
1922—3,857,000,000 gold lire	2,617,000,000 gold lire
1929—5,781,999,000 " "	4,041,000,000 " "

S. B. C.

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FASHODA QUESTION, THE, was the critical point of the Anglo-French dispute in 1898 over the Sudan. While the British under Lord Kitchener were attempting to conquer the Sudan from the Mahdi, a French force reached Fashoda (now Kodok) on the White Nile, with the object of tying up the French possessions in western Africa with their Red Sea posts. Kitchener induced the French commander, Maj. Marchand, to retire; but the dispute between England and France over possession of the head valleys of the Nile nearly led to war between the two countries. In 1904, by agreement between the two, France relinquished claims upon the Sudan in return for a guarantee of Morocco. *See ALGERIAS CONFERENCE.*

FAST DAYS, in religion, certain days on which the eating of meat is forbidden and general abstinence from food is recommended. The custom of setting aside fast days is very ancient and by no means exclusively Christian. (*See also FASTING.*) The voluntary fasting practiced by early Christians was gradually regulated by the Church; in general, time has decreased the number of fast days and their strictness. The fast days now appointed by the Church of Rome and the Church of England are the following: the day before partaking of the Holy Communion; the 40 days, except Sundays, of LENT; all Fridays except those falling between Easter and the Ascension or on Christmas Day; EMBER DAYS; ROGATION DAYS; and the VIGILS before certain feasts which do not fall on a Monday. Sunday is never a fast day. In con-

nection with Lent, the most important fast days are Ash Wednesday, when Lent begins, and Good Friday, when it ends. In the Eastern Church fast days are both stricter and more numerous.

FASTING, in religious parlance, either to go without food for a day or to abstain from meat and foods containing meat. Fasting has played an important part in the history of religion, partly as a practice of moderation and to overcome sensuality, and partly as an aid to the attainment of ecstasy and enthusiasm. It is also employed as a preparation for important decisions and acts, in times of mourning, and as a good work pleasing to God. In Oriental countries, where abstention from food is not so difficult as in northern regions, fasting as a method of bringing man nearer to the gods has been practiced since remote times. Both the Brahmans and Buddhists advocate the banning of meat and intoxicating drinks as a means of ending the course of reincarnations. Herodotus reports that fasting was in vogue in Egypt, where so many religious customs and beliefs arose, though the ancient Egyptian religion seemed far from ascetic. Zoroaster's sober religion of realism left no room for fasting. Among the Greeks and Romans there were traces of fasting, as among the Pythagoreans. Among the Jews it also became an important observance. According to the early law, fasting was prescribed only on the Day of Atonement (Leviticus 16: 29, 31; 23: 27, 32), but the Pharisees introduced two fast days per week (Luke 18: 12). The Jewish calendar listed fast days as memorials of national calamities, and the Talmud finally brought method and system into the practice of fasting. Later a distinction was made between whole and half fast days. In the first case food and drink are not taken from daybreak until the stars are visible, except on the Day of Atonement when the fast extends from evening to evening. Christian fasting began its development in very early times and has established LENT, EMBER DAYS and certain VIGILS as times of penitence and fasting. The Mohammedans also have a fasting period of 30 days.

FATES or **FATAE**, in Roman mythology, three goddesses of fate, called also the Moerae or Parcae. They were daughters of Nox and Erebus. CLOTHO, the youngest, presides over the birth of mortals, and is represented as holding a distaff and dressed in gay colors. LACHESIS is the sister who spins out man's life; she carries a spindle and her clothing is spangled with stars. ATROPOS, the oldest, cuts the thread of life; her dress is black and she has shears in her hand. The Fates are answerable to none, not even ZEUS.

FATHERS AND SONS, a novel of social and political changes in 19th century Russia, by IVAN TURGENIEV; published 1862. In this work, one of Turgéniev's finest, the often poignant conflict between old ideas and new is mirrored in two sets of characters. Standing for modernity are Arkady, a young student, who is bringing home his friend—and the book's hero—the arch-Nihilist, Bazarov. On the other side are Arkady's father; his uncle, the ruined old dandy, Pavel; and Bazarov's old father and mother.

FATHOM, a measure of length of the magnitude of six feet. It is used principally in nautical and mining measurements. The fathom originated as a natural measure, being the distance between the tips of a man's fingers when his arms were outstretched sideward. The depths of large bodies of water are measured in fathoms. In mining, the square fathom comprises 36 sq. ft. of a **VEIN**, measured on one of its walls and including its entire thickness. The available amount of ore worked on a fissure-vein is generally reckoned by the square fathom.

FATIGUE, a feeling of weariness or tiredness which develops either following exertion, or due to systemic conditions. There are a number of factors in the production of fatigue. When muscles contract to produce movement, lactic acid and other substances are formed in them. The accumulation of these substances in the muscles is responsible, at least in part, for the development of muscular fatigue.

Fatigue may result from the depletion of sugar in the body. In long sustained vigorous exertion, practically all of the available carbohydrate in the body may be used up, so that collapse occurs. Sugar depletion rarely develops to its full extent under ordinary conditions, but to a limited extent, it plays a part in industrial fatigue.

The ordinary type of fatigue encountered in the day's activities is probably in large measure a phenomenon of the nervous system. In prolonged work of moderate severity, it is likely that the nervous system tires before the muscles. The length of time required for this type of fatigue to develop is influenced by the general health and vigor of the individual. The depression of the nervous system, that may result from the fatigue of a small group of muscles, may influence the whole body, so that the legs may feel tired as a result of using the hands. Comparatively hard work involving the use of many muscles, but none to an extreme degree, may result in less general fatigue than intense activity involving extreme use of a small group of muscles. W. I. F.

Fatigue in Industry. In industry, controlled by machinery, the worker is often unable to rest when he becomes tired. Thus fatigue accumulates, and, since it accumulates more rapidly as time goes on, and, further, since a double quantity of fatigue requires more than a double quantity of rest for recovery, long spells of work are uneconomical.

To control the accumulation of fatigue, it is necessary to study the conditions of its appearance. These may consist of actual physical work done, the nervous and mental strain involved, and various circumstances connected with the surroundings of the worker, such as lack of space, lack of fresh air, lack of proper illumination, improper temperature and humidity of the air, excessive noise, or improper food.

The immediate causes of unnecessary fatigue having been identified, and removed, it remains to deal with that which is necessarily produced by the operations of the industry, even when these are carried on under the best possible conditions.

Here the advantage of "rest periods" is appreciated, since a period of rest introduced when a small amount of fatigue has accumulated leads to rapid recovery, while, if the amount of accumulated fatigue is great, it demands a period for rest disproportionately longer.

A. F. S. K.

FATIGUE OF MATERIALS. See **STRENGTH OF MATERIALS**.

FATIMITES. Early in the 10th century a Shiite insurrection against the Bagdad caliph broke out in North Africa under Obeidallah al-Mahdi, who claimed descent from Mahomet's daughter Fatima. When questioned he is said to have struck his sword with the remark, "Here is my genealogy." In 909 he proclaimed himself caliph at Kairwan. Within 60 years the Fatimites had conquered North Africa from Morocco to Egypt. In 972, they founded Cairo and made it the capital of their caliphate. When the last Fatimite died in 1171, Saladin, as sultan, assumed control of Egypt. The hostility of this Shiite state to the Sunnite Turks contributed to the success of the First Crusade. See **CRUSADES**.

FATS. See **ANIMAL FATS**; **ANIMAL OILS**; **VEGETABLE OILS**; **OILS**; **BIOCHEMISTRY**.

FATSHAN, a manufacturing city of China in the province of Kwangtung, on one of the branches of the delta of the Sikiang, about 12 mi. southwest of Canton. It has been called the "Birmingham of the East," but besides being noted for iron and steel manufactures, there is a large business in timber. Pop. 388,164.

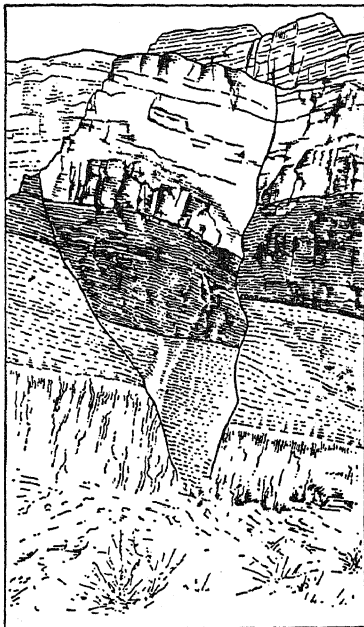
FATTY ACIDS, a very large and important class of compounds in organic chemistry, which may be considered as derived from aliphatic **HYDROCARBONS** by replacing one of the CH_3 groups at the end of the chain by a carboxyl group, COOH . They may be derived either from saturated or unsaturated hydrocarbons, that is from paraffins or olefines, in the first instance each carbon atom is attached to as many hydrogen atoms as possible, while in the second there is a "double bond"— $\text{CH}=\text{CH}$ —somewhere in the chain. The lower members of the paraffin series include such well known compounds as formic acid, acetic acid, butyric acid, related to methane, ethane and butane respectively, but the name fatty acids is often used in the more restricted sense of meaning only those acids containing from 12 carbon atoms upwards which, in the form of their **GLYCERIDES**, or glycerine esters, form the chief constituents of oils and fats. Foremost among these are the saturated compounds palmitic and stearic acid, of formulae $\text{C}_{16}\text{H}_{32}\text{O}_2$ and $\text{C}_{18}\text{H}_{36}\text{O}_2$, and the unsaturated oleic acid, $\text{C}_{18}\text{H}_{34}\text{O}_2$; stearic acid occurring chiefly in animal fats, oleic acid in vegetable oils. The esters of fatty acids and the higher monohydric alcohols such as cetyl alcohol, form the **WAXES**. The fatty acids are chemically related to, and may be obtained synthetically from primary **ALCOHOLS** and **ALDEHYDES** by oxidation.

W. J. L.

FAULT, in geology, is a dislocation of massive rock or of strata in bedrock, occurring along a **JOINT**

or fissure, by which a given bed on one side of the break is thrown out of line with its counterpart on the other. Pressure or tension strains due to readjustments of the earth's crust cause slipping or lateral sliding along lines of weakness in the rocks, which may produce tremors known as earthquakes.

Faults, which are seldom strictly vertical, are said to be *normal* when they appear to result from stretching of the crust, or *reverse* when a lateral thrust has



COURTESY U.S. GEOLOGICAL SURVEY

TWO FAULTS DISLOCATING THE ROCKS
EXPOSED IN A CANYON

caused one side of the broken strata to overhang the lower, so that a perpendicular line would intersect the same bed twice.

The movement in faulting may take place on both sides of the joint. It is often both up and down, and also sidewise. This is shown when faulting breaks a fence, leaving one end not only higher than the other, but laterally displaced. Displacements ranging from a few inches to 20 feet may occur in a few minutes. Faults separating a given stratum by thousands of feet, found in parts of the Colorado Plateau, are believed to represent the sum of repeated slight slippings during a long period.

FAULT-LINE. On geological maps traces of faults discoverable at the surface are indicated as fault-lines, and their direction is referred to as their trend. These sometimes run for great distances. The line described by the fault, which was responsible for the San Francisco earthquake of 1906, was traced for 600 miles.

Fault lines are often marked by cliffs, called fault-scarps. Where not reduced by erosion, these may reach mountainous heights, as in the eastern face of the Sierras. A fault-line intersecting a stream may be indicated by rapids, and waterfalls in small streams

often indicate faulting. The presence of a series of springs is to be expected along a fault-line, the waters rising from great depths through the natural fissure produced by the dislocation. Spring waters carrying mineral-matter in solution sometimes "heal" such fissures, with deposits or veins of more or less valuable minerals.

FAUN or **FAUNUS**, in Roman mythology, a deity of the woods and fields, the same as the Greek SATYR. The god of agriculture and of herdsmen and hunters, Faunus was also identified with PAN. His wife was Fauna.

FAUNA, the collective total of animals, usually indigenous, of any given geographical region or zoological period. The term is used as the correlative of flora, applied to plants. In studying the distribution of animal life, scientists have classified it according to faunal characteristics, as for instance in dividing marine animals into littoral fauna, pelagic fauna and abyssal fauna, according to their habits, appearance and the depths frequented. In geology and paleontology, the word fauna applied to the sum total of animals which inhabited any given region during a specific geological epoch, such a fauna being determined by the fossil remains deposited in the successive layers of that period. The word may be compounded, as avifauna, to particularize a division of animal life in a locality.

FAUNCE, WILLIAM HERBERT PERRY (1859-1930), American educator and theologian, was born at Worcester, Mass., Jan. 15, 1859. He graduated from Brown University in 1880 and Newton Theological Seminary in 1884. He was pastor of the State Street Baptist Church in Springfield, Mass., 1884-89 and of the Fifth Avenue Baptist Church in New York 1889-99. In 1899 he was called to Brown University as president and served for 30 years. Under his administration the university took a prominent place among institutions for higher education. Faunce was also active in furthering international peace. He died in Providence, R.I., Jan. 31, 1930.

FAUNUS. See FAUN.

FAURE, FRANCOIS FÉLIX (1841-99), French statesman, 6th President of the Republic, was born in Paris, Jan. 30, 1841. A poor boy, he won wealth as a merchant in Havre, fought in the Franco-Prussian War, and in 1881 was elected to the National Assembly. He entered the cabinet as an under-secretary in 1882 and in 1894 became minister of marine. In Jan. 1895, he was elected president of the Republic, and in 1897 he received with great ceremonial dignity the visit of the Czar of Russia in connection with the Franco-Russian alliance. Politically, he was a member of the Left group and was noted personally for his noble bearing. He died in Paris, Feb. 16, 1899.

FAUST. Behind this great legendary figure of the literature of northern Europe lies an actual person, Dr. Johannes, or George, Faust. He was born in Swabia about 1480, wandered about Germany, a boaster, self-styled physician and magician, and died

perhaps by suicide in 1539. The legendary figure, the man who sells himself to the devil to obtain the things of this world, took shape during the 16th century, the unworthy figure of the actual Faust serving as a focus of all the deep suspicions of the devilish character of worldly science which had clustered round the great names of Albertus Magnus, Roger Bacon, Pope Sylvester II and the Emperor Frederick II. The early Faust sells himself to Mephistopheles, preferring earthly knowledge to divine, for power, but essentially power for the things of this world. Even in Christopher Marlowe's *Doctor Faustus*, which gives the figure its most complete and dramatic expression in the earlier phases, Faust is still essentially so motivated. In this form Faust spread into all northern literature. For 300 years Faust plays of this type were the stock repertory of thousands of strolling players and puppet shows, particularly in Germany. LESSING in the 18th century gave the Faust figure a new development, turning with his times away from the old view of orthodoxy and heresy as unalterable opposites. From Lessing, GOETHE developed the figure of Faust to its last possibilities. Faust broods at midnight over what "in the innermost holds the universe together." It is the faint hope of having a little light on this that induces him to sign the compact with Mephistopheles. And it is in obtaining this, not through the aid of the mocking Mephistopheles, but by himself, that Faust is no longer damned.

FAUST, an opera in five acts by CHARLES FRANCOIS GOUNOD, libretto based by Jules Barbier and Michel Carré on the drama of the same name by J. W. von GOETHE. Première, Paris, 1859, London and New York, 1863. It is the most popular of Gounod's operas, taking precedence over *Romeo et Juliette*, and is also one of the great favorites in the standard repertory of all countries. The score was declined by numerous publishers, and Gounod finally sold it outright for \$2,000.

Faust, an aged philosopher, has become weary in his pursuit of pure wisdom. The hopelessness of his quest overwhelms him. In desperation he is about to drain a phial of poison when the cheerful song of maidens on their way to work enters his laboratory window with the sunrise. For a moment his thoughts are arrested, but as he listens the merriment outside only intensifies his bitterness as a man from whom youth has fled and joy departed. Cursing life which has utterly deprived him of youthful pleasures, he invokes Satan who at the same instant appears before him as Mephistopheles. Offering Faust the youth which he craves, if he will give his soul to his benefactor, Mephistopheles effects the transformation when the aged philosopher signs the document. At once Faust finds himself a young man, and without delay he proceeds to seduce Marguerite, a beautiful maiden. Her lover Siebel threatens to kill Faust, and her brother Valentine draws his sword in the attempt to do so, but Mephistopheles turns aside the thrust so that the sword ends the life of the would-be slayer. Deserted now by Faust himself as well as by all but

the faithful Siebel, Marguerite turns to seek comfort in the Church, but dares not enter a sanctuary since she has sinned too deeply. Finally, in prison, where she lies awaiting death for the murder of her infant, her mind wanders, the prison walls magically vanish, and she is borne upward and heavenward by a host of angels while Faust, now compelled to fulfill his contract with Mephistopheles, is borne by his tempter to the nether regions.

FAUVISM, a movement in French art inaugurated about 1896 by Henri Matisse and Marquet. A revolt against Impressionism, it attempted to synthesize Seurat's analytical composition, Gauguin's emphasis on design, Van Gogh's blazing color and Cézanne's structural idea of art. The chief interest of *Les Fauves*, or "the wild beasts," was in color. Unlike the Impressionists, who painted light, the Fauves concentrated on the painting of color; they wished their canvases to be full of color harmonies and flat tones. Thus their painting avoided the depiction of visual reality and became a play of color. Cézanne's ideal of arousing emotion by the formal arrangement of the subject, rather than by interest in the subject as such, was one of the keynotes of Fauvism. Henri Matisse, the leading member of the movement, said that he did not seek expression in the faces of his subjects or in violent movement, but rather in the disposition of the various objects of the composition. Other members of the group were Roualt, Derain, Dufy, Friesz, Vlaminck and Braque. Most of these men, with the exception of Matisse, later developed in other directions.

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FAVORED-NATION CLAUSE, a celebrated clause in treaties, which means that in matters of commerce and navigation the parties to the agreement shall extend to each other the privileges that are given the most favored nation. The United States has taken the view that RECIPROCITY in matters of navigation and commerce is not a gratuity but can be extended only for a valuable consideration. Great Britain has contended that concessions for which a consideration is given may be claimed under this clause. Since the World War, the United States has modified substantially its interpretation of this clause in the direction of the continental doctrine, i.e., unconditional most-favored-nation treatment.

FAVORITA, LA, an opera in four acts by GAETANO DONIZETTI, libretto based on Baculard-Darmaud's *Le Comte de Comminges* by Alphonse Royer and Gustave Waez; première, Paris, 1840, London, and New Orleans, 1843, New York, 1848. The opera retains its popularity chiefly in Italy.

The story deals with the love of Fernando, a novice in a monastery, for Leonora, who unknown to him is mistress of King Alfonso of Castile. He renounces the monastery and goes to Leonora who, fearing to reveal her relationship to the king, procures a military commission for Fernando. Later Fernando returns victorious to the court, after a battle against the

Moors, and the king gives a fête in his honor. A messenger arrives with word that the Pope will excommunicate the king unless he dispenses with Leonora. Meanwhile, Alfonso offers to reward Fernando by granting him any reasonable request, and the soldier asks for the hand in marriage of Leonora, still unaware of her relationship to the king. Alfonso grants the request, but Fernando learns the truth before the marriage, and returns to the monastery, after excoriating both Leonora and the king. The girl follows him to the monastery where, after begging forgiveness, she dies in Fernando's arms.

FAVRE, GABRIEL CLAUDE JULES (1809-80), French statesman, was born at Lyons, Mar. 21, 1809. He became a brilliant lawyer, and from 1830 on was an active republican. Consistently the enemy of Louis Napoleon, he joined Victor Hugo in 1851 in the vain effort to rouse the people against him. On the proclamation of the Empire he abandoned politics. In 1858, however, he re-entered the political arena as deputy for Paris. He became head of the Republican party in 1863, and in recognition of his distinguished gifts as an orator he was elected to membership in the French Academy in 1868. After the Franco-Prussian war he was made minister of foreign affairs to negotiate terms of peace; his ill-success in this difficult office led to his resignation in 1871. In 1876 he was made senator. He died at Versailles, Jan. 20, 1880.

FAWCETT, HENRY (1833-84), British economist and statesman, was born at Salisbury, Aug. 25, 1833.

He was totally blinded by a shooting accident in 1858, despite which handicap he continued his work in the field of political economy. A follower of Mill, he published a *Manual of Political Economy* in 1863, and in the same year was made professor of political economy at Cambridge. He entered Parliament in 1865. In 1880 he was appointed Postmaster-General, and in this office introduced the parcel post, postal orders, banking of small savings by stamps, and other reforms. He married Millicent Garrett, suffrage leader, in 1867. He was a lifelong supporter of woman suffrage, and also of proportional representation in voting. He died at Cambridge, Nov. 6, 1884.

FAWCETT, DAME MILLICENT, née GARRETT (1847-), English suffragist and author, was born at Aldeburgh, Suffolk, June 11, 1847, and educated in private schools. She was a foremost exponent for higher education for women and was for years leader of the constitutionalist group for woman's suffrage in England, as opposed to the militants. Upon her efforts, many bills for woman's suffrage were introduced in Parliament and rejected, until the triumph of the Representation of the People Act which enfranchised British women in 1918. For her signal work she was made Dame Commander of the British Empire and, in 1925 received the further honor of Dame of Grand Cross Order, of the British Empire. She is author of several literary works, among them, *Life of Queen Victoria* (1895), *Five*

Famous French Women (1906), *Women's Suffrage* (1912) and *Women's Victory* (1919).

FAWKES, GUY (1570-1606), English political conspirator, was born in York. He was baptized a Protestant, but later became an ardent Catholic, due it is thought to his stepfather. In 1593 he enlisted in the Spanish army of the Netherlands. He was chosen by Robert Catesby and the other conspirators in the GUNPOWDER PLOT as the man to execute their plans. They were discovered and Fawkes was hanged Jan. 31, 1606.

FAY, SIDNEY BRADSHAW (1876-), American historian, was born at Washington, D.C., on Apr. 13, 1876. He followed his graduation from Harvard in 1896 with study at the universities of Paris and Berlin. He became professor of history at Dartmouth in 1902. In 1904 he married Sarah Proctor. Leaving Dartmouth in 1914, he was professor of history at Smith from that year until 1929, and during 1917-28 he was visiting lecturer at Harvard University, Amherst College and Columbia University. In 1924 he was Round Table leader at the Williamstown Institute of Politics. Since 1929 he has been professor of history at Harvard. He has published the following works: *History Syllabus for Secondary Schools*, 1904; *Records of the Town of Hanover, N.H.*, 1761-1818, 1905; *Origins of the World War*, 1928, translated into German and French. He was the editor, with others, of *Smith College Studies in History* from 1915 to 1929 and the *American Historical Review* from 1924 to 1930. He has contributed to the *American Historical Review*, *Current History*, the *New York Nation* and the *New Republic*. His work on the origins of the World War is chiefly responsible for his recognition in the field of historical research and writing.

FAYAL. See AZORES.

FAYETTEVILLE, a city and the county seat of Washington Co., in northwestern Arkansas, situated on the White River, about 192 mi. northwest of Little Rock. A municipal airport, bus lines and the Frisco Railroad serve the city. The region raises fruits, especially strawberries, and grain. The city is a manufacturing center for hardwood products. The vicinity is beautiful country; the Ozark Mountains, Sulphur Springs and other objects of scenic interest are nearby. The State University, the State Experimental Farm, and the Western Methodist Assembly grounds are located in the city. Fayetteville was founded in 1828 and incorporated in 1836. Pop. 1920, 5,362; 1930, 7,394.

FAYETTEVILLE, a city and county seat of Cumberland Co. in southern North Carolina situated on the Cape Fear River, 60 mi. south of Raleigh. Bus lines and three railroads serve the city. Pope Aviation Field is 12 mi. west of Fayetteville. Cotton, tobacco, and corn are the chief crops of the vicinity. The city is an industrial center, manufacturing cotton, silk, rayon and pine products. In 1929 the value of the factory output was about \$5,000,000; the retail trade amounted to \$7,472,784. Fayetteville was founded by

Scotch settlers in 1739 and incorporated in 1783; and until 1791 was the capital of North Carolina. Sherman made his headquarters at Fayetteville in 1865. The city was for a time the home of Judah P. Benjamin, Attorney General of the Confederacy. Pop. 1920, 8,877; 1930, 13,049.

FAYUM or **FAIYUM**, an administrative division of Egypt, with an area of 670 sq. mi. and a population of 554,040 in 1927. The city, known as Faiyum or Fayum, has a population of 52,863. The division or province is a carefully cultivated oasis, and may be regarded as an outlying part of the Egyptian irrigated lands. It lies below sea level and obtains water from the Nile through the ancient Bahr Yusuf Canal.

FEATHER GRASS (*Stipa pennata*), a handsome ornamental plant, native to Europe and Asia, widely cultivated for its showy flowering panicle. It grows about 3 ft. high with a close, narrow flower cluster bearing long awns, often a foot in length, twisted below and delicately feathery above. *See also* ESPARTO; PORCUPINE GRASS.

FEATHER-STAR, an echinoderm belonging to the family *Comatulidae*, or hair stars. Feather-stars are crinoids which have lost their stems. They form a numerous family consisting of hundreds of species distributed among 98 genera, and found in every sea at all depths. They owe their name to their long wavy arms which are edged with tiny pinnules, so that they resemble delicate plumes. These arms, of which there are five, are quite distinct from the body, and may branch several times. Grooves lead to the feather-star's mouth from the arms and pinnules. They are lined with cilia which wave currents of water toward the mouth. From the constantly moving streams the animals obtain their food of minute organisms.

Feather-stars can crawl along the bottom, and even swim after a fashion, with their arms, but they usually remain fixed to some object on the sea floor.

FECHNER, GUSTAV THEODOR (1801-87), German physicist and philosophic writer, was born at Gross-Sachsen Apr. 19, 1801. In 1834 he became professor at Leipzig and devoted himself to the study of electrical phenomena. Later he turned to problems of color vision, natural science, anthropology and aesthetics, and published many works on these subjects and their interrelation. Fechner died at Leipzig, Nov. 18, 1887.

FECHNER'S LAW, a modification of WEBER'S LAW to increase its mathematical accuracy. The work begun by Weber was taken up by Fechner and reduced to the attempted science of PSYCHOPHYSICS. Fechner's statement of the relationship between the intensity of the stimulus on the one hand and the intensity of the sensation on the other is formulated as follows: $S = C \log R$, i.e., increased sensation is a logarithmic function of the stimulus. In other words, for any arithmetical increase in sensation there must be a corresponding geometrical increase in the stimulus. The law is based on the just perceptible differ-

ence as the unit of sensation. It assumes that equally perceptible increments are equally large when perceived, an assumption which is by no means true. The same increased stimulus, added to a hundred-weight and a pound, will not be felt equally, although the ratio may be constant.

FEDERAL COUNCIL OF THE CHURCHES OF CHRIST IN AMERICA, the official instrument for cooperative activities in the United States of important Protestant evangelical denominations with an aggregate membership of 22,000,000. The council was organized in 1908. It is an experiment in the larger Christian unity for jointly bringing the power of the Christian religion to bear on the complex and practical problems of modern civilization, at the same time preserving liberty and diversity in the theology, polity and worship of the constituent denominations. In 1931 the constituent denominations were: Northern Baptist Convention. National Baptist Convention. Free Baptist Churches. Christian Church. Churches of God in North America. Congregational Churches. Disciples of Christ. Evangelical Church. Evangelical Synod of North America. Friends. Methodist Episcopal Church. Methodist Episcopal Church, South. African Methodist Episcopal Church. African Methodist Episcopal Zion Church. Colored Methodist Episcopal Church in America. Methodist Protestant Church. Moravian Church. Presbyterian Church in the United States of America. Presbyterian Church in the United States of America (South). National Council, Protestant Episcopal Church (cooperating body). Reformed Church in America. Reformed Church in the United States. Reformed Episcopal Church. Seventh Day Baptist Churches. United Brethren Church. United Presbyterian Church. United Lutheran Church (consultative body).

With the Federal Council there are numerous affiliated and consulting bodies, such as the Y.M.C.A. and Y.W.C.A., the American Bible Society, the Student Volunteer Movement for Foreign Missions, and similar organizations. The council as a whole consists of 400 members, all appointed by the constituent denominations, and meets every four years. An executive committee of 125 members meets once a year, and an administrative committee of about 70 members meets monthly. Through 10 important commissions, each with its own executive, leadership is given in special forms of Christian service, working through state and local federations of the churches.

FEDERAL DISTRICT (*Distrito Federal*), in Mexico, a small territory bounded on the northeast and west by the state of Mexico and on the south by Morelos. It is the seat of supreme power of the republic, and also the commercial, social and political center. Of irregular outline, it has an area of 578 sq. mi. The government of the district is patterned from that of the District of Columbia in the United States. Besides MEXICO CITY, the capital of Mexico, several small towns lie within its borders. Chapultepec, the summer residence of the president, is the chief of these. Pop. 1921, 906,063; 1930, 1,217,663.

FEDERAL FARM BOARD, an organization provided for in the Agricultural Marketing Act of 1929, consisting of eight members appointed by the President. It was formally constituted on July 15, 1929. It is directed to use its powers in an effort to place the industry of agriculture on a basis of economic equality with other industries, principally pursuing four lines of attack, as follows: 1. Minimizing speculation, 2. Preventing inefficient and wasteful methods of distribution, 3. Encouraging the organization of producers into cooperative associations for the marketing of their products, 4. Aiding in preventing and controlling surpluses in any agricultural commodity. The Board was given large powers and a sum of \$500,000,000 to advance to producers of farm products through their cooperatives, and for financing any price stabilization activities which it might undertake. Its principal activities have been bringing together cooperative associations into a number of national and regional agencies handling grain, cotton, wool and mohair, livestock, beans, fruit, pecans and tobacco; loaning to cooperative associations; setting up grain and cotton stabilization corporations for the purchase of these commodities in periods of market demoralization; and extensive buying and selling, principally buying thus far, of wheat and cotton with a view to stabilizing prices of these commodities. The Board has also tried to get farmers to reduce their production of some of the more seriously depressed commodities. J. D. B.

FEDERAL FARM LOAN ACT OF 1916, an act setting up a farm loan system which is a compromise between the complete joint responsibility provisions of many of the European cooperative credit systems and the complete individual responsibility characteristic of American agricultural credit arrangements. The system consists of a **FEDERAL FARM LOAN BOARD** located in Washington, 12 Federal Land banks, and the numerous national farm loan associations chartered by these banks on application from local groups of farmers. Loans are made only through these local farm loan associations. They are repaid on an **AMORTIZATION** basis, usually over a 35-year period. Funds are secured by the sale of tax-free **BONDS** jointly secured by the twelve banks. The act also provides for a second set of loaning agencies, the **Joint Stock Land banks**, whose capital stock is subscribed by private investors. These make loans directly to individuals. Up to Sept. 30, 1930, a total of \$1,641,175,314.87 of loans has been made through the Federal Land banks, and \$891,988,708.66 through Joint Stock Land banks. The act was amended in 1923 to provide for 12 Intermediate Credit banks in conjunction with the Federal Land banks. These banks have made loans mostly to cooperative marketing agencies. The total of their outstanding loans on Sept. 30, 1930, was \$123,335,958.65.

J. D. B.

FEDERAL GOVERNMENT, a form of governmental organization in which the powers of government are divided by the national constitution be-

tween the central and local governing authorities in such a manner as to grant the local units real **AUTONOMY** in matters of vital local importance. In the form of Federal organization typified by the United States, the Constitution accords to the central government certain specified powers. The residue of power remains in the hands of the states or the people thereof. In the exercise of the authority delegated to it, the central or Federal government is supreme; in respect to the residue, the power of the states remains unimpaired. A citizen of the United States is consequently subject to two sets of laws enacted by two independent governing bodies each supreme within the sphere allotted to it. In contrast to the distribution of powers between the central and local authorities in the United States is the situation which exists in Canada. In this British Dominion the American system has been exactly reversed. Certain specified powers have been reserved to the provinces, the residue of power has been delegated to the Dominion authorities.

The allocation of power between the central and local authorities in a Federal government varies from state to state. The essential tests of Federalism, however, are the constitutional allocation of powers between the two units of government, together with constitutional provisions designed to protect the local units in the exercise of their rights.

The Swiss Republic, the United States of America, the Dominion of Canada, Australia and South Africa were in the days prior to the World War outstanding examples of Federal states. S. C. W.

BIBLIOGRAPHY.—C. A. Beard, *American Government and Politics*, 1924; S. C. Wallace, *Our Governmental Machine*, 1924.

FEDERALISTS, in United States history, those who favored the adoption of the Constitution, 1787-88; and, 1789-1816, members of the political party first associated with the measures of Alexander Hamilton and later with the interests of the mercantile and manufacturing classes. The conflicting tendencies evident in the struggle for adoption of the Constitution (*see* **ANTI-FEDERALISTS**) in President Washington's administration produced the first political parties, with the Republicans, or Democratic-Republicans (*see* **DEMOCRATIC-REPUBLICAN PARTY**), attempting to prevent the extension of the powers of the National Government by enforcing strict adherence to the letter of the Constitution (*see* **STRICT CONSTRUCTIONISTS**). The Hamiltonian Federalists favored, 1789-1801, Hamilton's measures for the funding of the national debt; the first Bank of the United States, and Hamilton's excise policy. They preferred friendly relations with Great Britain, opposed giving countenance to the French Revolution, and supported the **ALIEN AND SEDITION ACTS**. Under Presidents Washington and John Adams the Federalists were the party in power. Thereafter, as the opposition party, although they theoretically favored liberal construction of the Constitution as a means of advancing the rights of property, they perforce inconsistently opposed the **LOUISIANA PURCHASE** and other Jeffersonian measures as un-

constitutional. The party lost strength as personal dissensions arose between its leaders, Hamilton and Adams; as the development of the West produced an electorate of democratic tendencies hostile to the aristocratic tinge of the Federalist party; and as Jefferson, the Republican leader, proved himself a master of tactful political leadership, while Adams became personally unpopular. The Federalists, important only in New England by the close of Jefferson's second term, opposed the EMBARGO, NON-INTERCOURSE ACTS, and the WAR OF 1812. Popular exaggeration of the "treasonable" aspects of the HARTFORD CONVENTION, 1814, practically forced the dissolution of the Federalist party.

FEDERAL RESERVE ACT, THE, an act to provide for the establishment of Federal Reserve banks, to furnish an elastic CURRENCY to afford a means of rediscounting COMMERCIAL PAPER, to establish a more effective supervision of banking in the United States and for other purposes, passed Dec. 23, 1913.

Public interest in the improvement of the country's currency and banking system developed during the last decade of the 19th century, largely because of lack of elasticity in the supply of CREDIT and currency. In 1897 a nongovernmental monetary commission was organized, which in its report recommended measures of banking and currency reform. Some of these recommendations were incorporated in the Currency Act of 1900, which established the GOLD STANDARD and also contained provisions to encourage the growth of national banks. Following the money panic of 1907 the attention of Congress and the public was again focused on banking reform, and in 1908 the Aldrich-Vreeland Act was passed, providing for an emergency currency to be secured by State and municipal BONDS and commercial paper. This act also established a National Monetary Commission which made an extensive study of banking and currency conditions here and abroad and in 1911 recommended a plan incorporated in the Aldrich bill. This bill, however, which provided for a national reserve association with branches in different sections of the country, was not adopted.

When in 1912 the DEMOCRATIC PARTY came into power, it undertook to carry out banking reform. Work on a banking bill was started in April 1912 by a subcommittee of the House Banking and Currency Committee of which the Hon. Carter Glass was chairman; on Dec. 23, 1913, the Glass-Owen bill, known as the Federal Reserve Act, was approved by President Woodrow Wilson. This act provided for the establishment of autonomous regional Federal Reserve banks, from 8 to 12 in number, under the general supervision of a Federal Reserve Board appointed by the President with the advice and consent of the United States Senate. *See* FEDERAL RESERVE SYSTEM.

E. A. G.

FEDERAL RESERVE BOARD AND BANKS.

See FEDERAL RESERVE SYSTEM.

FEDERAL RESERVE SYSTEM, THE, a banking system established by the FEDERAL RESERVE ACT

OF 1913 that began operation on Nov. 16, 1914. The system consists of 12 regional Federal Reserve banks functioning under supervision of a governmental agency, the Federal Reserve Board. The Reserve banks have 25 branches and two agencies. Each Federal Reserve bank with its branches functions as a central reserve institution in a geographical area, the boundaries of which were determined with regard to the convenience and customary flow of business.

All national banks (*see* BANKS) are required to be members of the Federal Reserve system, and eligible state banks can join it voluntarily. The entire capital stock of the Federal Reserve banks is owned by the member banks, which must subscribe 6% of their own capital and surplus; of this amount one-half has been paid in. Member banks receive a 6% dividend on their stock in the Federal Reserve banks. Net earnings of these banks in excess of expenses, dividends and prescribed transfers to surplus, are paid to the United States Government as a franchise tax.

The Reserve banks are managed by boards of directors consisting of nine members, of whom three are appointed by the Federal Reserve Board and six are elected by the member banks from persons representative of the districts' business and banking interests. The Federal Reserve Board designates one of the appointed directors as chairman of the board of directors and Federal Reserve agent, representing and reporting to the Board. The principal executive officer of each bank, known as the governor, as well as all other officers and employees, are chosen by the board of directors.

The Federal Reserve Board, a governmental supervisory and coordinating agency, is composed of the Secretary of the Treasury, ex-officio chairman, the Comptroller of the Currency, ex-officio member, and six members appointed by the President "with due regard to a fair representation of financial, agricultural, industrial, and commercial interests, and geographical divisions of the country." One of the appointed members is designated by the President as governor. The salaries of members of the Board are fixed by law and the board's expenses are met by an assessment on the Federal Reserve banks in proportion to their capital and surplus.

The Board, in order to follow developments in the various districts, holds conferences in Washington at least four times a year with the Federal Advisory Council, a statutory body, members of which are elected by the boards of directors of the Reserve banks; on more frequent occasions with the governors of the 12 Reserve banks, and at least once a year with the Federal Reserve agents.

One of the principal purposes of the Federal Reserve system is the consolidation of bank reserves and their use as a basis for loans to member banks at times of seasonal or other temporary needs. Each member bank keeps on deposit with the Reserve banks prescribed percentages of its net demand and time deposits, and these reserve balances alone count as the legal reserves of the member banks. Member

FEDERAL RESERVE SYSTEM

banks may borrow from the Reserve banks, in response to changing currency (*see* MONEY) and credit needs, and thereby temporarily increase their reserves and their lending power. Such loans to member banks may be made by the Reserve banks on customers' paper of not more than 90-day maturity—agricultural and livestock paper with a maturity up to nine months is eligible for discount—offered for rediscount by the member bank and on the member banks' own fifteen-day collateral notes secured by customers' paper or by Government obligations. In order to be eligible for DISCOUNT, paper must originate from industrial, commercial, or agricultural transactions, and must not be drawn for investment purposes or for trading in or carrying of securities, except obligations of the United States Government. Discount rates charged member banks are established by the

tem, under which currency is issued whenever the business of the country requires it and is returned to the Reserve banks as soon as the need has passed, the country's currency system has been made highly elastic, and money of all descriptions in circulation increases and decreases promptly in response to changes in the requirements of the public.

Federal Reserve banks must hold 35% reserves in gold or lawful money against their deposits and of 40% in gold against their Federal Reserve notes in actual circulation. The Federal Reserve Board has authority to reduce or suspend these reserve requirements temporarily under prescribed conditions.

Federal Reserve banks have authority to purchase in the open-market certain classes of paper, enumerated in the act, the most important being BANKERS' ACCEPTANCES, and United States Government securi-

PRINCIPAL RESOURCES AND LIABILITIES OF FEDERAL RESERVE BANKS: MARCH 11, 1931

(In thousands of dollars)

FEDERAL RESERVE BANK

	Total	Boston	New York	Philadelphia	Cleveland	Richmond	Atlanta	Chicago	St. Louis	Minneapolis	Kansas City	Dallas	San Francisco
<i>Resources</i>													
Total reserves	3,280,546	227,098	1,166,202	244,985	319,836	115,519	165,071	402,484	114,369	67,605	101,495	52,759	303,123
Bills discounted for member banks ..	172,550	8,777	38,082	21,928	18,881	17,563	14,431	15,884	8,158	3,808	11,274	7,546	6,218
Bills bought in open-market	151,402	11,316	49,392	2,372	15,886	1,695	8,089	21,701	7,792	4,573	7,005	4,191	17,390
United States Government securities ...	604,704	46,368	188,258	50,358	58,107	17,122	10,186	81,486	24,025	26,090	34,132	29,331	39,241
<i>Liabilities</i>													
Federal Reserve notes in actual circulation	1,445,855	126,550	255,965	137,506	181,273	80,916	130,641	153,330	76,815	47,832	66,033	26,843	162,144
Member bank reserve deposits	2,435,520	144,013	1,067,683	145,774	195,348	60,914	60,653	325,583	69,508	47,633	81,423	57,319	179,669
Government deposits	33,124	1,947	11,323	1,675	3,400	3,236	884	2,709	1,471	831	1,642	2,254	1,752
Other deposits	16,944	33	8,145	173	1,656	87	91	477	351	101	287	28	5,515
Capital paid in and surplus	443,660	33,149	146,255	43,847	44,747	17,860	16,111	59,911	15,426	10,201	12,955	13,260	29,940

Reserve banks with a view of accommodating commerce and business and are subject to the review and determination of the Federal Reserve Board. The review and determination of discount rates and the definition of the character of the COMMERCIAL PAPER that may be accepted as eligible for rediscounting within the meaning of the act are among important functions of the Federal Reserve Board. The Board also has the power to authorize, or in its discretion to require, any Federal Reserve bank to rediscount paper held by another Reserve bank, and so make surplus funds in one district available to meet a temporary deficiency in another district. In effect, this power consolidates the reserve resources of the system.

The Federal Reserve banks are authorized to issue Federal Reserve notes, against which an equal amount of collateral consisting of GOLD or eligible paper must be deposited with the Federal Reserve agents. Through the operation of the Federal Reserve sys-

ties. In practice the Reserve banks purchase acceptances when offered, at buying rates determined in accordance with market conditions. Purchases and sales of Government obligations, on the other hand, are made largely at the Reserve system's initiative, the time, manner, character and volume of such transactions being governed with primary regard to their effect on the business and credit situation. These open-market operations, which are to a large extent expressions of the credit policy of the system as a whole, are undertaken after consideration at meetings of an open-market policy conference, consisting of representatives of the 12 Federal Reserve banks, meeting with the Federal Reserve Board.

In addition to the functions already described, the Reserve banks act as fiscal agents of the United States Government, and render other services, such as the clearing and collection of CHECKS and the furnishing of cash required by member and nonmember banks. The board maintains a gold settlement fund, through

which inter-district balances of payment arising from commercial and financial transactions and fiscal operations are daily cleared by wire. The Federal Reserve Board regularly examines the Federal Reserve banks and branches, and has authority to examine all member banks. In practice, the examination of national banks is conducted by the Comptroller of the Currency and the examination of member state banks is handled by the Federal Reserve system through cooperation with the banking commissioners of the various States.

A table showing principal assets and liabilities of the 12 Federal Reserve banks for Mar. 11, 1931, is given herewith. E. A. G.

FEDERAL SPECIFICATION BOARD. See STANDARDIZATION; SPECIFICATIONS.

FEDERAL TRADE COMMISSION, a body created in 1914 as a part of the antitrust program to which President Woodrow Wilson had committed himself in the campaign of 1912. Wilson had opposed such a body during the campaign, but found it necessary as an instrument for attaining his other objectives. The Commission replaced the Bureau of Corporations created in 1903. However, the new organization was invested with materially broader responsibilities and powers. The Bureau had been primarily an investigating body, whereas the Commission added to this function that of administering certain sections of the law creating it and of the CLAYTON ACT.

The Commission is comprised of five individuals, appointed by the President, by and with the advice and consent of the Senate, for terms of seven years, at a salary of \$10,000 per year. No more than three commissioners may be members of the same political party. Members are not permitted to engage in any other business, vocation or employment. Subordinate to them is a large corps of lawyers, economists, accountants, clerks and stenographers.

In carrying out its investigatory and administrative work the energies of the Commission have tended to center more and more upon the enforcement of Section V of the Federal Trade Commission Act. This section declares illegal "unfair methods of competition in commerce," and authorizes the Commission to proceed against alleged users of such methods by instituting hearings in which the truth of said allegations is to be determined. If a majority of the commissioners decide the respondent is guilty, a cease and desist order restraining the continuance of the practices is entered, and in case it is disregarded the Commission may carry the matter to a circuit court of appeals for affirmation of its order. The respondent has the right to appeal to such a court for a review of the order. In either case the court may affirm, modify or set aside said order. Decisions of circuit courts of appeals are final except that they may be reviewed by the Supreme Court upon certiorari. The success of the Commission in administering Section V of its organic statute has been material. Supported by the courts it has somewhat broadened the concept

of unfair competition long recognized at common law and has checked many undesirable practices. Of recent years the majority of the orders issued fall into five general classes: misbranding, passing off, false and misleading advertising, resale price maintenance, and misrepresentations of various sorts. In addition the work of the Commission in seeking to put a check to commercial bribery is highly commendable.

The more strictly economic activities of the Commission have resulted in a series of extremely valuable reports on numerous industries, notably petroleum, tobacco, steel and electric power. Consequently, despite some handicaps imposed by the procedure laid down by Congress for enforcing Section V, and by the appointment at times of commissioners largely out of sympathy with the purposes of the act creating the body, it has performed services of great value.

C. A. G.

FEDERATION. See CONFEDERATION.

FEE. Freehold estates are classified as Estates of INHERITANCE and Life Estates. Inheritable estates may be estates in 1. Fee Simple or, 2. in Fee Tail.

A fee *simple* ESTATE is the largest interest possible in land. It is inheritable in quality. The holder may alienate the land, or he may dispose of it by WILL. At one time the words "and his heirs" were required to be added after the name of the grantee if a fee estate passed. It is now usually otherwise by STATUTE.

On the other hand, an estate in *fee tail* is inheritable only by the bodily descendants of the tenant. TAIL is derived from the French, meaning "to shorten." An estate tail may be limited to the HEIRS of the body, to "heirs male of the body" or to the heirs of the body begotten of a certain named wife. Entailed estates are no longer favored, and by legislation they somewhat approximate fee simple estates or life estates with an interest over.

A. E. E.

FEEBLE-MINDEDNESS, called also mental deficiency, a disorder characterized by subnormal mental development. Of the many definitions given, those adopted by the British Royal Commission on the Care and Control of the Feeble-minded are most satisfactory and most generally used. Three levels of mental deficiency are defined separately: (1) Idiots are persons so defective in mind from birth or from an early age that they are unable to guard themselves from common physical dangers, such as, in the case of young children, would prevent their parents leaving them alone. (2) Imbeciles are persons who are capable of guarding themselves from common dangers, but who are incapable of earning their own living by reason of mental defects. (3) Feeble-minded are persons who may be capable of earning a living under favorable circumstances but are incapable of competing on equal terms with their normal fellows, or of managing themselves and their affairs with ordinary prudence. In the United States the term "moron" is used as is the term "feeble-minded" above, and idiots, imbeciles and morons are classed under the general head of feeble-minded.

The principal causes of mental deficiencies are family predispositions, germ injuries through alcoholism, syphilis and other diseases which constitute about 60 per cent. Other causes are brain and general disease of the foetus or child, particularly meningitis and encephalitis. Mental deficiency can be caused by disease after birth, but injuries are a rare cause. Disease or malformation of the mother is another uncommon cause. The occurrence varies in different localities, from 1 to 5 per 1,000 population.

Among the *early manifestations* of mental deficiency are (1) difficulty and inability to learn to take the breast, (2) violent, continued and unprovoked crying, (3) impossibility of fixing the child's gaze, (4) lack of expression in the physiognomy. Symptoms observed in the early childhood are backwardness in walking and talking. The child does not learn to dress, drink from a cup, handle a spoon, use proper discrimination in food at an age proportionate to other children. It is at the *school age* that the higher types of feeble-mindedness may be first observed. The inability to learn is soon discovered in the modern school and any child that is three years behind his proper grade is in most cases mentally deficient. In *adolescent and adult life* the characteristic symptoms of mental deficiency relate to social and economic adjustment. Such symptoms as the following are found: inability to secure work, or failure in keeping it when found; lack of ambition because of mental inadequacy or repeated failure; a state of mind that is willing to accept charity habitually; delinquency, crime, and prostitution, because they require a minimum of intellectual competition.

In no case of mental deficiency can recovery be expected, but with the higher types a good deal can be accomplished by the proper training. Treatment in all cases consists of training and education, segregation, and employment under supervision. Intelligence tests have been devised that indicate fairly well the intellectual level of the individual, and this status tells roughly what might be expected from the training. Modern institutions over the country for the care of the feeble-minded have become so highly developed and so well supervised, that they offer the best solution for the care of these people. Also feeble-minded do much better when placed with those of their own intellectual level. For the lower types, permanent segregation is necessary. Institutional training in four cases out of five will result in individuals who are able to produce something of value to the community. At home they are a burden and a care. In the higher types it is possible to give sufficient training so that the individuals can return to the outside world and make their living. Due to the fact though that even the brighter classes of feeble-minded are weak in will power and judgment, it is now thought that institutional care is better and cheaper for the community.

Some states have passed laws calling for sterilization and castration of the feeble-minded. *See also* INSANITY; MENTAL DEFICIENTS, EDUCATION OF.

M. Q. H.

FEED PUMP, a power-driven high-pressure pump used to force water into a **BOILER** against the pressure of the steam. Feed pumps may be either reciprocating or centrifugal. In design, the feed pump has developed from a single-cylinder single-acting unit to a compound double-acting reciprocating unit and a multi-stage centrifugal unit. Modern boiler installations are either single or double-acting single-cylinder or compound reciprocating units or single- or multi-stage centrifugal units, the latter being of integral-case or split-case design. Reciprocating feed pumps are designed for pressures from 15 to 300 pounds per square inch and for capacities up to 500 gallons per minute; centrifugal pumps for pressures up to 2000 pounds per square inch, capacities up to 3000 gallons per minute and speeds ranging from 700 to 3550 revolutions per minute. *See also* PUMPS.

FEEDS, CONCENTRATED, for livestock, the finer less bulky feeding stuffs containing a relatively large proportion of digestible food nutrients. The water and less valuable food constituents as crude fiber (cellulose) are present in small amounts, while the content of the more valuable food constituents as **PROTEINS**, **STARCH**, **SUGAR** and **FAT** is relatively high. In nearly all cases concentrated feeds of vegetable origin are the seeds of plants, or are made from such seeds; those of animal origin are by-products in the slaughter of livestock, in the making of butter, or in the packing of fish.

Cereal Products. The production of **CORN** far exceeds that of any of the other cereals. Since the content of protein is relatively low and that of starch is high, the main usefulness of corn in the ration is to provide nutrients for energy and fattening. For this purpose corn has no superior, and is relished by all kinds of livestock. Yellow corn is preferred to white corn on account of its higher content of vitamin A. Gluten feed and gluten meal are the residues after a large part of the starch is removed from the corn. Both of these contain generous quantities of protein and the former especially is much used in the rations of dairy cows. Hominy feed, the portion remaining from the manufacture of hominy and some kinds of corn meal, can be substituted for corn in the ration.

OATS are of the same general composition as corn except that they contain more fiber and are more bulky. These characters are due to the woody hulls which surround the kernels of the oats. They are extensively used in the feeding of all kinds of livestock except swine and poultry. **BARLEY** resembles corn and oats in composition. The hulls on the barley kernels comprise a much less proportion of the total weight than is the case with oats. For this reason barley is better suited to the feeding of swine than is oats.

WHEAT is not an economical feed for livestock except when the price per pound drops to near that of corn, which it resembles in composition and feeding value. It may then be used more or less liberally in place of corn, depending upon the kind of livestock fed. Wheat is especially favored for poultry and is also well-adapted to swine feeding. By-products in the

manufacture of FLOUR from wheat are valuable and widely used feeds. Wheat bran containing a medium amount of protein and a generous amount of mineral matter, is used mainly as a cattle feed but is also fed to a limited extent to other kinds of livestock. Another by-product, middlings, is used extensively as a feed for swine and to a lesser extent as a feed for cattle and poultry. Other cereals used in smaller quantities are the grain sorghums, KAFIR and milo, and RICE. The grain sorghums are similar in composition and feeding value to corn. Rice bran and rice polish are fed to cattle, swine and mules.

Animal Products. Skimmilk and buttermilk, though not conforming strictly to the definition of concentrates, are much used in butter-making districts to take the place of high protein concentrates in the feeding of swine, calves and poultry. Skimmilk is milk from which the cream is removed; buttermilk is the product remaining after butter has been removed from cream. In physiological effects no feeds are superior to these. Dried skimmilk and dried or condensed buttermilk are articles of commerce and are much used for poultry and calf feeding.

Tankage is the heated, dried and ground waste from meat packing houses. It is made of those parts of the animal carcass which are unfit for human food. Being an animal product and containing much protein and mineral matter it is well-suited to the feeding of omnivorous animals such as swine.

High Protein Concentrates. In the order of the extent of their use, including both vegetable and animal products, these rank somewhat as follows: cottonseed meal, linseed meal, skimmilk, tankage, peanut meal, soybean meal, and fish meal.

Cottonseed meal is the ground cake resulting from the decortication, heating and pressing of cottonseed in the extraction of cottonseed oil. It is relatively cheap and is used extensively for cattle feed. Linseed meal is made by heating and pressing flax seed to remove the oil and then grinding the resulting cake. It is a safe and valuable feed for all kinds of livestock.

Peanut meal, the by-product resulting from the expression of the oil from hulled peanuts, is a palatable and suitable feed for all kinds of livestock, as is also soybean meal, the residue after the oil has been pressed from soybeans.

Fish meal is a by-product in the extraction of oil and in the preparation of fish for human food. It has a high content of protein and mineral matter and is a suitable feed for swine and poultry.

Miscellaneous Concentrates. These include such feeds as beet pulp and molasses. Beet pulp is the residue from the extraction of sugar from the sugar beet. When dried it has a nutritive value approximately equal to that of cereal grains. It contains much carbohydrate material but little protein and fat. On account of its bulky nature it is widely used in the feeding of dairy cattle. Molasses is used extensively in the preparation of commercial mixed feeds for cattle and horses. It improves the palatability of the feed and is often a cheap source of carbohydrates.

Ready-mixed feeds are extensively used for different kinds of livestock but particularly for poultry and dairy cattle. These feeds are generally made up of various cereal grains or by-products from cereal grains, with such quantities of high protein concentrates or animal products as are necessary to make the ration suitable for the kind of livestock fed. T. E. W.

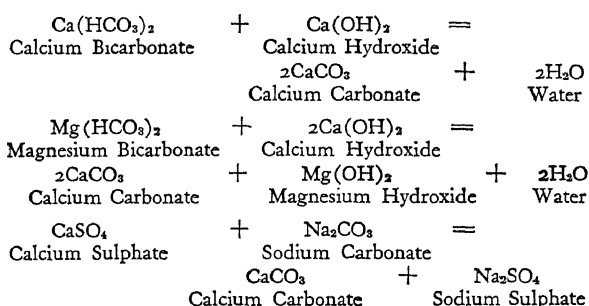
FEED-WATER HEATERS, apparatus for raising the temperature of water before it is admitted to a BOILER. Feed-water heaters are of two general types, open and closed. The open type utilizes the heat of STEAM by bringing it into direct contact with the water. It consists essentially of a shell which encloses trays over which the feed-water flows. A special type of open heater in which water is sprayed in jets into a chamber filled with steam is called a "jet" heater. In closed heaters the water does not come into direct contact with the steam, but is confined to tubes with the steam outside, or vice versa.

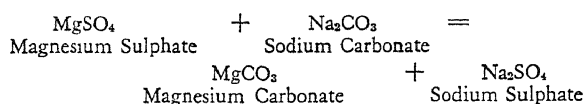
Exhaust steam is generally used to supply heat to feed-water heaters, but sometimes steam is taken from one or more "stages" of a turbine. When high-pressure stages are tapped, strongly constructed closed heaters called high-pressure "bleeders" are used.

Feed-water heaters equipped with some device to degasify the water are termed deaerating heaters.

FEED-WATER TREATMENT, the process of removing impurities from water used in steam BOILERS. Natural water is rarely of sufficient purity to be entirely satisfactory for use in boilers; and the type of treatment which it requires, depends upon its chemical composition, the type of boiler and the specific operating conditions of the plant. In general, a satisfactory boiler feed water is one which will deposit no incrustations on the heating surfaces (*see* BOILER CORROSION), will not corrode metal and will have no marked tendency to "foam" under steaming conditions of the boiler. Distillation, with attendant removal of the dissolved gases, is the most satisfactory form of feed water treatment that can be used but, owing to its relatively high cost, it is limited to use in condensing steam generating stations, where "make-up" water is the only new water introduced into the boiler. *Softening* is a widely practiced form of feed water treatment since, by this process, the majority of the scale forming solids can be removed.

Softening may be effected, by adding slacked or un-slacked LIME, SODA ash or BARIUM salts to the water. The characteristic chemical reactions for this method are as follows:





On account of the solubility of the MAGNESIUM carbonate produced in the last reaction, a sufficient amount of caustic lime is added to the water to convert this salt into the hydroxide: $\text{MgCO}_3 + \text{Ca(OH)}_2 = \text{Mg(OH)}_2 + \text{CaCO}_3$. SODIUM hydroxide is sometimes used to precipitate magnesium sulphate, but it is not effective for the precipitation of calcium sulphate, since calcium hydroxide, which is quite soluble is formed. When caustic soda is employed to soften water containing magnesium sulphate, the following reaction results: $\text{MgSO}_4 + 2\text{NaOH} = \text{Na}_2\text{SO}_4 + \text{Mg(OH)}_2$.

The above chemical reactions proceed in either cold or hot water but the speed of reaction is greatly accelerated as the temperature of the water is increased. The insoluble compounds formed are removed by subsidence in settling tanks or by filtration through a porous medium. Sodium aluminate, phosphates, aluminum sulphate, caustic soda and other chemicals are at times employed in addition to the above softening reagents already mentioned. The hardness of water softened by either hot or cold-process softeners will average about two grains per gallon, if the process proceeds at 212°F . or higher.

An improved method of feed water treatment for boilers, to prevent internal corrosion or growth of scale, is known as the Hall System and was developed by Dr. Hall, formerly connected with the United States Bureau of Mines. Dr. Hall's work extended over a period of several years, commencing approximately 1922, and is built upon the principle that it is possible to maintain the various constituents of the water in the boiler in such proportions that precipitation will form as a loose sludge, easily removed by blowing down or continuous filtration, rather than as adherent scale.

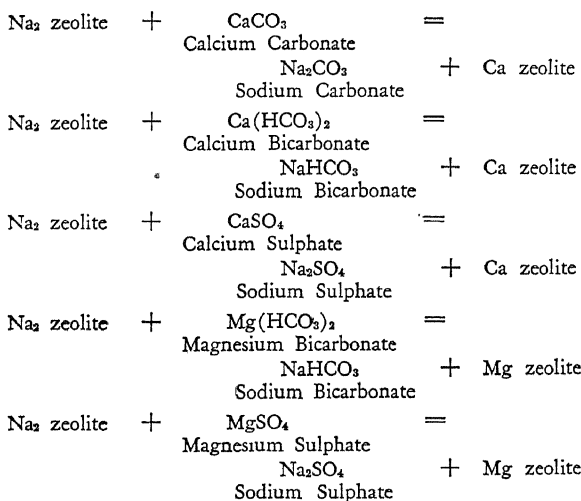
A simplified method of testing in the boiler room has been developed so that the sulphate concentration, the amount of which is dependent on the amount of sulphate in the boiler and the percentage of blow-down, is quickly determined. For any given boiler pressure and concentration of sulphate, reference to simplified formulas and constants will show the minimum concentration of carbonate that must be maintained to prevent the formation of adherent scale. Soda ash is usually added for this. Carbonate concentration is also measured by a simplified apparatus.

In the higher steam pressures, that is, above 250 lbs. per sq. in. gage, soda ash tends to break down into a sodium hydroxide. Under these conditions, sodium phosphate is substituted for soda ash.

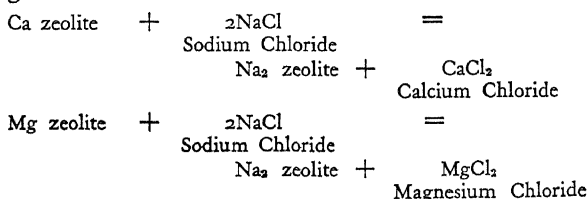
The system of treatment has been reduced to simple form so that while it was originally developed through careful and painstaking research, it is now used in boiler rooms of all sizes, large and small, and does not require technical knowledge of the men operating

Softening may also be obtained by the use of

zeolite, a process which has advanced rapidly during recent years. This method consists of passing water through a bed of zeolite minerals, which possess the property of removing calcium and magnesium, the chief scale forming constituents, and replacing these substances with sodium salts, which are highly soluble and ordinarily do not form incrustation. The exchange takes place rather rapidly and the hard water may be almost completely softened by merely passing through the zeolites. Natural zeolite is a complex hydrosilicate of which there are a number of types. Zeolites prepared synthetically are also used. A zeolite mineral will continue to soften water until all or practically all the sodium salts have been exhausted from it and is capable of reducing the hardness to one grain per gallon, or less. When the sodium of the zeolite bed has been practically exhausted the mineral must be regenerated, that is, the sodium which has been removed during the softening process must be replaced. This is effected by treating the mineral with a solution of sodium chloride or common salt. A reverse action then takes place, the calcium and magnesium extracted from the water by the zeolite passing into the brine solution and sodium becoming fixed in the mineral. The hypothetical reactions which take place in softening water by these substances may be expressed as follows:



The reaction which takes place when the bed is regenerated with salt solution is as follows:



One of the most important problems of feed water treatment is the removal of dissolved gases from water in order to inhibit corrosion of the boiler and auxiliary apparatus. Extraction of these gases, usually termed deaeration, may be effected either by mechanical apparatus or by the use of chemicals. In a large ma-

jority of deaerating systems the degasification of the water is effected by mechanical apparatus. When feed water contains mineral or organic acids it should be treated with an alkaline salt to neutralize the acidity. Sodium salts are preferable to calcium or magnesium for this purpose, since sodium salts do not form scale. Another important problem in feed water treatment is the maintenance of a proper ratio of sulphate to carbonate in the concentrated water in the boilers under steaming conditions. If this is not done there is the potential danger of the steel cracking due to CAUSTIC EMBRITTLEMENT. Chlorination is a recently developed method of feed water treatment, being employed to destroy the bacteria in the water which produce slime fouling in condenser tubes.

S. T. P.

FEELING, SENSE OF. See NERVES.

FEHLING, HERMANN (1811-85), German chemist, was born at Lübeck, June 9, 1811. He became professor of chemistry at Stuttgart in 1839 and devoted himself to technical problems. His discoveries improved the technique in baking and tanning and his discovery of Fehling's Solution as a means of chemically determining the presence of sugar filled a long-standing need. He died at Stuttgart, July 2, 1885.

FEIJOA (*Feijoa Sellowiana*), called also pineapple guava, a shrub of the myrtle family native to southern Brazil and adjacent countries where its fruit is highly valued. In 1890 it was introduced into southern France and Italy and a decade later into southern California. The shrub is highly ornamental with olive-like leaves, glossy-green above, silver-gray beneath, and large white flowers with purplish crimson centers and stamens. The oblong dull green fruits are often crimson cheeked, and are about 2 in. long. The granular flesh contains translucent melting pulp with pineapple flavor, and the seeds are so small that they are not noticed when eaten. Though generally used as dessert, the fruit is cooked or preserved in various ways. The plant prefers a mild, not tropical climate, and strong, well-drained but moist loam. It will stand temperatures as low as 15° F. but does not thrive in excessive humidity and heat. The feijoa is propagated by seeds germinated in sand; when about 4 in. high the seedlings are transplanted.

FEIJÓ, DIOGO ANTONIO (1784-1843), Brazilian statesman, born Aug. 17, 1784 in São Paulo. After the completion of his studies Feijó took Orders and became a teacher. Later he left the Church altogether. In 1821 Feijó was sent to Lisbon to represent Brazil at the cortes but fled in disgust and returned to Brazil. He sat as a deputy in the first two imperial parliaments, where he urged the abolition of ecclesiastical celibacy and municipal reform, and in 1833 he entered the Senate, representing the province of Rio de Janeiro. In 1831-32, after the abdication of Dom Pedro I, he became minister of justice and showed his energy and statesmanship in pacifying the country. Feijó was made sole regent of the empire, the first elected head of Brazil, from 1835 to 1837, when

he resigned, because of opposition. In 1842 he is alleged to have taken part in a revolution in São Paulo and was arrested by the government.

FEITH, RHIJNVIS (1753-1824), Dutch poet, novelist and dramatist, was born at Zwolle in Oberyssel, Feb. 7, 1753. He was educated at Harderwijk and at the University of Leyden. Feith achieved social and political success at an early age. In 1780 he was chosen Burgomaster of Zwolle. His writings are uniformly infected with the melancholy and gloom characteristic of the *Werther* period of German prose and poetry. Feith's works include *Odes and Poems*, 1796-1810, *Thirza*, 1791, a tragedy, *Resuscitation of Lazarus*, 1811, a tragedy, and *Julia*, 1783, a novel. The pessimism of his novels and tragedies was attacked critically and often parodied by contemporaries. Feith died at Zwolle, Feb. 8, 1824.

FELDSPAR, a group of rock-forming silicates, usually light in color, essential constituents of most IGNEOUS ROCKS. All are silicates of aluminum and an alkali or alkaline earth, or both. Two groups are generally recognized, ORTHOCLASE, crystallizing in the MONOCLINIC SYSTEM with two cleavages at right angles, whence the name; and PLAGIOCLASE, triclinic with oblique cleavage, one cleavage face showing striations. The orthoclase group includes orthoclase, a white silicate of potassium and aluminum, and MICROCLINE, green, with the same composition and almost the same crystal form, although crystallizing in the TRICLINIC SYSTEM.

The plagioclase group comprises a series varying regularly from albite, a sodium aluminum silicate, through oligoclase, andesine, labradorite and bytownite to anorthite, a calcium aluminum silicate. Anorthoclase is intermediate between orthoclase and albite. Orthoclase, microcline, albite and oligoclase are also called acid feldspars, and labradorite and anorthite basic feldspars.

Albite and anorthite are white, oligoclase and andesine are white, reddish, grayish or greenish, bytownite is greenish, and labradorite gray, brown, greenish or colorless, frequently showing a beautiful play of colors.

Feldspars are estimated to make up 50% of the igneous rocks, and 16% of the sedimentary ones, so are of widespread distribution. They weather to KAOLIN and CLAY. Feldspars are used in ceramics as a bond and for glazes because of their low melting-point. Occasionally they are used for abrasives. Stone composed of LABRADORITE is used for decorative purposes. Important production of feldspar in the United States comes from North Carolina and Maine. See also SANDSTONE; SAND; PETROLOGY; ARKOSE; MINERALOGY; PEGMATITE; MOONSTONE; SERICITE.

FELIX, name of several popes and an antipope St. Felix I, 269-274. Felix II, an antipope who substituted for Pope Liberius during his banishment, 355-358, when the latter returned. St. Felix III (II), 483-492, excommunicated the Patriarch of Constantinople for heresy and thus brought about the first schism between the Eastern and Western churches. St. Felix IV (III), 526-530, illegally designated Boni-

face II as his successor, who was disregarded by the electors. Felix V, 1439-49, antipope to Eugenius IV. He was first Duke of Savoy and abdicated to become a priest.

FELIX, ANTONIUS, Roman procurator in the time of St. Paul, who kept St. Paul in prison for two years. He is mentioned both by Josephus and Tacitus as unworthy of the great power that he possessed. During his short rule of eight years Jerusalem was fermenting with insurrection and rebellion, which Felix violently though unsuccessfully attempted to crush. Felix was recalled by Nero in 60 A.D.

FELIX OF VALOIS, ST. (1127-1212), a French monk, one of the founders of the Order of the Holy Trinity, was born in Valois, France, Apr. 19, 1127. He was of the House of Valois but he surrendered his property and became a forest hermit in the diocese of Meaux. Here he was joined by St. John of Matha, who conceived the idea of establishing an order to redeem captives, which was confirmed by Pope Innocent III in 1198. Margaret of Valois gave the order land in the forest to which Felix had first retired, and there the monastery was built. Felix was canonized by Urban IV in 1262, and died at the monastery of Cerfroi Nov. 4, 1212.

FELL, JOHN, DOCTOR (1625-86), English scholar and divine, was born probably at Longworth, Berkshire, June 23, 1625. He was educated at Oxford, was made Dean of Christ Church College, Oxford, in 1660 and became Bishop of Oxford in 1675. As dean he did much to improve the buildings of his college and was active in promoting the University Press. He edited many Greek and Latin classics. His chief work was *The Principle of England Stated*, 1659, and he is thought to have been the author of *The Whole Duty of Man* and to have edited *A Paraphrase and Annotations of the Epistles of St. Paul*, 1675. He died at Oxford, July 10, 1686. Dr. Fell will perhaps always be remembered for the lines written by the wit, Tom Browne (1663-1704), which purported to be a translation of Martial's epigram,

Non amo te, Sabidi, nec possum dicere quare;
Non tantum possum dicere, non amo te

which Browne translated thus:

I do not love thee, Dr. Fell,
The reason why I cannot tell;
But this I know, and know full well,
I do not love thee, Dr. Fell.

FELLENBERG, PHILIPP EMANUEL VON (1771-1844), Swiss educator, was born at Berne, June 27, 1771. He was educated at Tübingen. After 1799 he settled on an estate near Berne and endeavored to work out better methods of agriculture and new theories in education. He was the originator of manual training in schools and established separate schools for orphans, poor boys and the gentry in an effort to provide education suitable for each class and to create sympathy and understanding among them. His methods greatly influenced the teaching in American schools of the early 19th century. At Whitesbor-

ough, N.Y., a Fellenberg School of Agriculture was established in 1831, and numerous other schools, both of agriculture and of manual education, owed their inspiration to this original-minded educator. Fellenberg died at Hofwyl, Nov. 21, 1844.

FELLOW, in educational usage, a graduate student to whom a university grants a stipulated sum over a definite period of time to carry on research work in his particular line of interest. The fellow is not necessarily a graduate of the university giving the fellowship, and though the research work is usually done at this university, it not infrequently is done elsewhere. Usually the selection is based on evidence of unusual ability or promise in some special field. See FELLOWSHIP.

FELLOW-SERVANTS, persons working for a common "master." Many court decisions deal with the question of the master's liability when one servant is injured by the negligence of a fellow-servant. These decisions have crystallized in what is called the "Fellow-Servant Rule," which is that a master is not liable for injuries to a servant caused by the negligence of a fellow-servant engaged in the same general business where the master has exercised due care in the selection of the fellow-servant. This rule has been largely abolished by legislation providing for compulsory workmen's compensation. C. E. KE.

FELLOWSHIP, an appointment to a student, carrying a stipend to enable him to complete post graduate work involving a Ph.D. degree, though sometimes for advanced professional work. In America the appointment and title are usually for a single year, or at least are effective only for a specified time. In Great Britain the title and emoluments may exist during life. A fellowship is usually distinguished from a scholarship in that a fellowship is given only for post-graduate work and carries a greater stipend. These distinctions may be confused, however, as in the case of the RHODES SCHOLARSHIPS which, in America, would technically be considered fellowships. See FELLOW.

FELONY, at common law, an offense conviction for which involved forfeiture of lands and goods to the Crown. Originally all felonies were punishable by death. Forfeitures for felony were abolished in England in 1870. In the United States statutes generally define a felony to be a crime, conviction for which is punishable by death or imprisonment in a penitentiary or state prison for more than a year.

FELONY, COMPOUNDING OF, the offense of agreeing with a felon not to prosecute in consideration of some benefit. It is committed by one who was directly injured by the felony. The taking back of stolen goods, with the agreement not to prosecute or assist in prosecuting the thief, or advertising for stolen goods, "no questions asked," have both been considered criminal.

FELSITE, a group of IGNEOUS Rocks which are usually light in color and of a dense texture, but not glassy. The group includes the RHYOLITES, DACITES and TRACHYTES which have cooled so rapidly that crystals did not have time to form well, and it is

difficult or impossible to distinguish them on the basis of their component minerals. Hence the felsites belong in the ACID ROCKS, and correspond with the dark-colored BASALTS which are the fine-grained equivalent of the BASIC ROCKS such as DIORITE and GABBRO. They are usually found in small intrusions, as of dikes and sills, and in surface lavas. *See also* PETROLOGY.

FELT, a textile fabric whose manufacture eliminates the usual spinning and weaving operations by using the felting characteristics of its wool content to shrink a carded fluffy bat of fiber into cloth of suitable tensile strength.

Cotton, nolls and shoddies are blended with clip wool. Hair must be used alone. The first operations are blending, mixing, and carding on woolen cards. A bat is then built up by doffing a full width film from the final card and laying it down on an endless traveling apron. This bat is compressed and shrunk on a hardening machine, followed by further shrinking in pusher fulling mills, during which process the goods are removed several times and "over-hauled," or pulled back to width. Further operations are scouring, extracting, dyeing, shaving and pressing.

Hair felt and sheet felt are formed quite differently but their manufacture is dependent on similar hardening and fulling operations. F. A. H.

FEN, low-lying marsh land. The famous fens of England, in Lincolnshire, and adjoining countries along the Wash, represent immense tidal marshes, from which the Romans first shut out the sea. Modern drainage and dyking has reclaimed 60,000 to 70,000 acres of fertile, humus-rich land. Original wild fenland now remains only east of the River Cam, and southeast of the Isle of Ely. A district along the Muddy River, in Boston, Mass., is known as the Back Bay Fens. Fens contrast sharply with bogs in that the soil is not acid. *See* Bog.

FENCES in agriculture, are light structures enclosing fields, serving as a barrier to live stock. The wire fence is the principal type built to-day. In range country two or three strands of barbed wire are usually adequate as a fence; woven wire is needed in built-up farming areas; and board fences are best for corrals. The wire is strung tight between large well-braced posts of wood, concrete, or metal about 10 rods apart and suspended on smaller line posts about a rod apart. All wire fencing should be heavily galvanized.

FENCING, the use of sword or foil, generally the latter, for attack and defense. In its modern sense, fencing is the art of single combat with foils, and is governed by international regulation. The art, or more properly, science of fencing has evolved from sword play, the first records of which are found among Assyrian and early Greek inscriptions. The Romans developed a lighter sword than the weapons of their predecessors; but the heavy armour of the medieval knights necessitated a return to a weighty, cumbersome blade. Not until the early 14th century, when gunpowder was invented, were steps made toward

the present-day foil, a light balanced blade which, while diverting the enemy's point, may reply with a dangerous thrust. For four centuries this light and flexible sword underwent refinement. Fencing was taught widely until the end of the 18th century, when men apparently realized that proficiency in the science was no proof of their probity. Thenceforth fencing was largely governed by rules.

The modern foil, generally 33 inches in length, has no cutting edge, the attack being delivered with the point, which is covered with a button. The target is restricted to the bust of the opponent, which for black-board discussion is divided into four sections, *sixte* and *tierce*, or upper right; *quarte* and *quinte*, upper left; *octave* and *seconde*, lower right, and *half-circle* and *prime*, lower left. There are two parries, direct or circular, to each of the foregoing sections. The attack aims to touch the opponent; a *touché* is sometimes known as a *coup*. Some fencing schools train pupils to attain this end by feinting, followed by one of the three chief attacks: the straight thrust, disengage and cut-over. The celebrated *riposte* is a quick return thrust following a parry. In addition to foil fencing, there is *épée* fencing, in which are counted all touches on an adversary, and saber fencing, primarily a cutting engagement. In the United States fencing has found increasing favor. American fencers scored high in individual competitions at the 1928 Olympic Games. Since 1921 the United States and Great Britain have competed for the Robert M. Thompson Perpetual Trophy. The American team won in 1921, 1926 and 1930.

FÉNELON, FRANÇOIS DE SALIGNAC DE LA MOTHE (1651-1715), French churchman and author, was born in the château of Fénelon, Périgord, Aug. 6, 1651. Educated at the University of Cahors, he went to Paris in 1666, and, being of noble family, was soon introduced at the court of Louis XIV, where in 1689 he was appointed tutor to the Duke of Burgundy, the Dauphin's oldest son. For his royal pupil he wrote his highly imaginative books, *Télémaque*, *Fables* and *Dialogues of the Dead*. In 1695 he was made Archbishop of Cambrai, and in 1697 he published *Maxims of the Saints*, the mysticism of which was attacked by Bossuet, who brought about Fénelon's dismissal from court. In later correspondence with his pupil, Fénelon wrote criticisms of the government of Louis XIV which have never been forgotten, and in several respects his thought was far in advance of his time. He died at Cambrai, Jan. 7, 1715.

FENGTIEN, the original name of the southern of the three Manchurian provinces, and also of the capital of this province. The city was called Mukden by the Russians. In 1928 the name of the province was changed to Liaoning and that of the city to Shenyang.

FENIAN RAIDS INTO CANADA. The Fenian Society in America, placed on a firm basis in 1858 by James Stephens and John O'Mahoney, was an offshoot of the Irish Revolutionary Brotherhood

in Ireland, the object of which was to convert its members into a soldiery capable of resisting the British. In the Civil War a large proportion of the Irish soldiers on either side were members of Fenian circles, or locals. After the Irish uprising of 1865 had been suppressed, the Fenians in America determined to bring about an international crisis favorable to Ireland by invading Canada. Plans called for 50,000 Irish-Americans to cross the border, carrying additional ammunition for the Canadian-Irish. In the spring of 1866 Fenians began to gather along the border in New York and Vermont; they were not interfered with by Federal or state officials. Canadian authorities placed 16,000 militiamen along the border; but a Fenian army of more than 1,500 troops did not materialize. On June 1, 1866 the Fenians crossed the border, captured Ft. Erie from a troop of Canadian militia, announced a de facto Republic of Ireland, with a constitution modeled after that of the United States, with Capt. W. R. Roberts, U.S. Army, president, and called upon the Canadian-Irish to flock to their standard. On June 3 a large body of Canadian troops approached Ft. Erie, and the Fenians retreated. The U.S.S. *Michigan* arrived off Ft. Erie, and the entire Fenian army was arrested and taken aboard. The prosecution was dismissed; the Government paroled 5,000 Fenians who had expected to cross the border, and paid their railway fares home. Some Fenians whom the Canadians had captured and prosecuted received death sentences, but the United States succeeded through diplomatic negotiations in getting those sentences commuted. In 1866 and 1867 the House of Representatives passed resolutions favorable to the Fenian movement. In 1870 and 1871, however, Fenian plans for other invasions of Canada were thwarted by the United States Government, and the Fenian movement collapsed.

FENIANS, a group of Irish revolutionists, organized in the Fenian Brotherhood, who had left Ireland after the short uprising in 1848. They sought by a worldwide league of their countrymen to free Ireland. They were particularly active from 1858-70, many individual acts of minor violence being committed in Ireland and England. The most notorious act of the Fenians was the raid on Ft. Erie, Canada, by 800 Fenians in 1866, repulsed by Canadian troops. The second Fenian raid in 1870 was more easily suppressed. One of its chief organizers was a British secret agent.

FENNEC (*Fennecus zerda*), the smallest member of the dog family, a pretty fox-like animal inhabiting the deserts of northern Africa. Its fur practically matches the sand, and, when pursued, it escapes by digging into the sand so quickly that it seems to be diving into water. It is about a foot in length without the bushy tail, which is 8 in. long. The most characteristic features are the ears, each as large as the face and giving it a quaint expression of intelligent alertness. By day fennecs lie curled up in their burrows, softly lined and kept remarkably clean. At sunset they emerge to drink and hunt for small beasts or fruit.

FENNEL (*Foeniculum vulgare*), a smooth pleasant-scented herbaceous plant of the parsley family. It is a native of southern Europe, commonly cultivated for its aromatic fruits and leaves, used medicinally and in flavoring. The erect stem grows from 3 to 5 ft. high, bearing finely divided leaves composed of threadlike segments and numerous clusters of yellow flowers, in large umbels.

FENUGREEK (*Trigonella Foenum-Graecum*), a heavy-scented annual of the pea family, native to southern Europe, where it was extensively grown in ancient times for spring forage and for its seeds used medicinally. Abandoned largely throughout Europe, its cultivation is still continued in India and the Nile valley. The plant grows about two feet high, bearing leaves of three leaflets, whitish flowers, and long seed-pods with slender curved beaks.

FERBER, EDNA (1887-), American author, was born at Kalamazoo, Mich., Aug. 15, 1887. After filling various positions as a newspaper woman in Appleton, Wis., Milwaukee and Chicago, she began to write fiction. In 1911 she published *Dawn O'Hara*. The *Emma McChesney* stories, first published in *The American Magazine*, appeared in book form in 1915. Her first outstanding success, *So Big*, was awarded the Pulitzer Prize in 1925. Her *Show Boat* was dramatized, 1928, and later produced as a motion picture. With George Kaufman, she wrote *The Royal Family*, and, in 1932, *Dinner at Eight*. Among Edna Ferber's other works are *Cimarron*, 1930, and *American Beauty*, 1931.

FER-DE-LANCE, a popular name given in the French West Indies to a species (*Lachesis lanceolatus*) of poisonous snake, widely distributed throughout the Antilles and Central and South America. It is a pit viper, closely related to the copperhead, and less closely, to the rattlesnake, which it much resembles in appearance. The tail, however, is pointed and without a rattle. This snake is brown, marked with black, and may be 7 ft. long. It is nocturnal in habit, and lives on rats and similar small animals. Usually it is not much inclined to use its poison fangs, and has even been carried about by people who did not realize it was poisonous, without ever attempting to bite. When it does strike, however, there is no warning, and death is almost inevitable. Other common names for the fer-de-lance are rat-tailed viper and lance-headed snake.

FERDINAND, name of seven Spanish kings. Ferdinand I, the Great, united Castile and Leon by his marriage to Sancha of Leon and made important Mohammedan conquests. He died in 1065. Ferdinand II, of Leon, died 1188, 2nd son of King Alphonso VII of Castile, whom he succeeded in Leon, Asturia and Galicia, gained victories over the Portuguese and the Moors. Ferdinand III, the Saint, King of Castile (1199-1252), united Leon to Castile, captured many cities from the Moors and founded Salamanca University. Ferdinand IV (1285-1312), of Castile, undertook an unsuccessful attack on Granada and left his kingdom in confusion. Ferdinand V

(1452-1516), 1st King of united Spain. Ferdinand VI, (1713-1759), had able ministers who aided the peasants, improved finances, the army and navy, furthered science and held the Inquisition in check. Ferdinand VII (1784-1833), became king when the French entered Spain in 1807 and Charles IV abdicated in Ferdinand's favor. He was forced by Napoleon to renounce his crown but in 1814, after his reinstatement, his rule was reactionary and unsuccessful.

FERDINAND I (1793-1875), Emperor of Austria, was born in Vienna, Apr. 19, 1793. He was crowned King of Hungary in 1830, and succeeded his father, Francis I, as Emperor of Austria Mar. 2, 1835. He was an ineffectual ruler and as a result of the outbreak of the revolution in Vienna, he fled, May 1848, to Innsbruck. Recalled by the Diet in August, he resigned the government into the hands of his nephew, Francis Joseph, in December. He died at Prague, June 29, 1875.

FERDINAND I (1861-), King of Bulgaria, was born Feb. 26, 1861, in Vienna, the son of Prince Augustus of Saxe-Coburg. He was elected prince of Bulgaria, July 7, 1887, and became king when the independence of Bulgaria was proclaimed in 1908. He was active in the promotion of the BALKAN LEAGUE and the Balkan War against Turkey, 1912-13. Bulgaria entered the World War on the German side in Sept. 1915. When the war ended, Ferdinand abdicated in favor of his son, Boris, and retired to Coburg.

FERDINAND I, surnamed "The Great" (d. 1065), King of Castile and Leon, was the second son of Sancho III of Navarre. In 1035 Ferdinand was made king of the newly created independent kingdom of Castile, acquired in 1028 by his father. In 1037 after the defeat and death of his brother-in-law Bermudo of Leon, he became king of Leon. He assumed the title of emperor of Spain in 1056 in defiance of the Holy Roman Emperor, Henry III, and as an assertion of independence which pleased the Spaniards. Ferdinand fought successfully against the Moors and opened the way to the later conquests of Toledo, Saragossa and Seville. He died at Leon, Dec. 27, 1065.

FERDINAND V (1452-1516), the "Catholic," King of Castile, was born at Sos, Aragon, Mar. 10, 1452. In 1466 he was associated with his father John II in the government of Navarre and in 1468 became King of Sicily. In 1469 he married Isabella, sister of Henry IV of Castile and on Henry's death in 1474 Ferdinand and Isabella became King and Queen of Castile. By 1515 he had united under one rule the four Spanish Kingdoms of Aragon, Castile, Granada and Navarre as well as Sicily and Naples and had laid the foundations for the most brilliant period of Spanish history. The Inquisition was established during his reign, 1480, the Moors and the Jews were driven out, 1492, and America was discovered by Columbus, 1492. He died at Estramadora in 1516.

FERDINAND I (1865-1927), King of Rumania, was born at Sigmaringen, Prussia, on Aug. 24, 1865.

Charles I of Roumania having no son, the succession passed to the family of Prince Leopold of Hohenzollern-Sigmaringen; thus, Ferdinand, the son of Leopold, became heir-presumptive to the Roumanian throne in 1889. He married Marie, the daughter of the Duke of Edinburgh, in 1893. In 1913 he commanded his country's forces against Bulgaria, having reorganized them prior to the outbreak of the war. On Oct. 14, 1914 he became king of Roumania. In 1916, although a Hohenzollern, he declared war on Germany, because he felt it necessary to protect the national unity of Roumania. His fate and that of Roumania was doubtful during the occupation of Bucharest by the Germans and the collapse of Russia, but he saved his country from invasion by repulsing the enemy at Marasesti. In 1918 Roumania annexed Bessarabia, Bucovina, Transylvania and the Banat, King Ferdinand being crowned king of all the Roumanians in 1922. Agrarian reforms, the modernization of the army, universal suffrage, the extension of civil rights to Roumanian-born Jews, and the conversion of large estates into small properties were some of the benefits that followed the war. Ferdinand died on July 20, 1927.

FERGUS FALLS, a city in western Minnesota, the county seat of Otter Tail Co., situated on the Otter Tail River, 200 mi. northwest of Minneapolis. Bus and truck lines and two railroads serve the city. There is an airport. Fergus Falls is a shipping center for grain, chickens and turkeys. The manufactures include flour, woolen goods, sashes and doors, tiles and caskets. The hydro-electric power plant serves over 300 towns in the state. The city is the seat of Park Region College and Northwestern College. Fergus Falls, in the Park Region section of Minnesota, was founded in 1856 and became a city in 1881. Pop. 1920, 7,581; 1930, 9,389.

FERGUSON, ROBERT (1750-74), Scottish poet, was born at Edinburgh, Sept. 5, 1750. He was educated at St. Andrew's University, and worked as a copyist. In 1771 he began to contribute poems to *Ruddiman's Weekly Magazine*, and these won him considerable reputation. Excesses, however, brought on ill-health, and a fall caused insanity. Fergusson's work strongly influenced Burns, who in 1789 erected a tombstone over the poet's grave. He died at the Darien House Asylum, Edinburgh, Oct. 16, 1774.

FERMAT'S THEOREM, one of the various theorems proposed by Pierre de Fermat. It states that the equation $x^n + y^n = z^n$ has no general solution in case n is greater than 2. The general proof of this theorem has never been effected, although proofs for particular values of n have been found. Another theorem which bears Fermat's name asserts that if a is any integer and p is a prime number, then $a^{p-1} - 1$ is divisible by p . For example, $3^{5-1} - 1 = 80$, which is divisible by 5.

FERMENTATION, a chemical decomposition or rearrangement of organic compounds brought about during the growth of micro-organisms or by their **ENZYMES**. Numberless chemical reactions come under

this definition, including most of those encountered in disease and decay, but the most important are the fermentations utilized in chemical production. All fermentations are caused by some variety of bacterium, mold or yeast, as a consequence of their vital activities. Prominent among these are the industrial production of butanol and acetone from starch by bacteria, citric acid from cane sugar by molds, and ALCOHOL from starch or sugar by yeast. Micro-organisms are also employed in the manufacture of lactic acid, acetic acid, butyric acid, gluconic acid, gallic acid, and glycerine. Their use in foods is equally important. The following may be listed among the materials in the production of which fermentation plays an important part: Alcoholic beverages, cheese, sauerkraut, bread, vinegar, olives, cocoa and chocolate, cured meats, pickles, tea and coffee. It has been estimated that one billion dollars is the total annual production value in the United States of foods, exclusive of alcoholic beverages, in the manufacture of which some form of fermentation is utilized.

Fermentations are not limited to chemicals and food. Micro-organisms play their part in tanning, the retting of flax, the manufacture of tobacco, the production of various industrial enzymes, the growth of leguminous vegetables, the preparation of therapeutic agents and the disposal of sewage. There are also numerous laboratory fermentations, prominent among which are the utilization of cellulosic wastes in the production of fuel gas, the lower fatty acids, and ethanol, which give promise of successful translation to larger spheres of activity. All in all, there are few fields of life, constructive or destructive, in which micro-organisms do not find their application.

H. T. H.

FERNALD, MERRITT LYNDON (1873-), American botanist, born in Orono, Me., Oct. 5, 1873. He became an assistant in the Gray Herbarium at Harvard in 1895 and graduated from Harvard University with a B.S. degree in 1897. His teaching career began with an instructorship in botany, 1902-05, at Harvard, where in 1915 he became Fisher professor of natural history. Fernald has been noted chiefly for his studies in the relationship of North American and old world plants. He has been connected with the magazine, *Rhodora*, being associate editor from 1890 to 1928 and editor-in-chief since 1928.

FERNANDEZ, JUAN (1536-c. 1602), Spanish navigator, born in 1536. He made many voyages along the Pacific coast from Panama to Peru and Chile. He navigated these voyages so skilfully that he was called the "wizard" and was believed to have bewitching powers. He discovered the island which bears his name, and tried to set up a fishing station there but did not succeed. His other discoveries were St. Felix and the St. Ambrose Islands. About 1590, he retired, poverty stricken, to Quillota in the Chilean mountains, where he died c. 1602.

FERNANDO DE NORONHA, an island of the South Atlantic Ocean, lying 125 mi. from the eastern coast of Brazil, of which it is a possession. The sur-

face of the island, which is about 8 by 2 mi. in extent, is mountainous, hills rising about 1,000 ft. in height. The soil is fertile in parts, but little of it is cultivated. There is a penal settlement in which some 12,000 convicts are confined. Aside from the convict population, and the garrison which numbers about 150, there are only about 400 inhabitants.

FERNDALE, a residential city and suburb in Oakland Co., Mich., situated adjacent to Detroit on the north. Ferndale is served by buses, the Grand Trunk Railroad and an electric line. This city is almost entirely residential, but has a few manufactures, including steel tubing, tools and dies and paints and varnishes. In 1929 the retail trade amounted to \$7,497,310. Ferndale was incorporated as a village in 1918 and as a city in 1927. Pop. 1920, 2,640; 1930, 20,855.

FERNS, the most highly developed group (*Filicales*) of the flowerless plants, distinguished for their graceful habit of growth and handsome foliage. There are about 6,000 species, found very widely throughout the world, but occurring in greatest variety and luxuriance in moist tropical regions. Ferns range in size from delicate moss-like plants to towering treelike structures somewhat resembling palms. Most ferns rise from a creeping underground stem (rhizome) and only the leaves, more correctly called fronds, and their stems, known as stipes, are seen above the ground. In the case of tree-ferns, the fronds grow in a circle at the top of the hollow stem, forming a huge rosette. The interesting mode of reproduction in ferns, consisting of an asexual and a sexual phase, is described under PTERIDOPHYTES. Ferns are found in maximum abundance in humid tropical islands. In Java, for example, about 600 species occur, while in the entire United States there are only about 300. The native North American ferns include the bracken, polypody, maidenhair, shield fern, chain fern, ostrich fern, sword fern, lady fern, royal fern and gold fern. Because of their highly decorative foliage many ferns are cultivated as ornamentals, as the Boston fern, staghorn fern, hart's-tongue fern and holly fern. Notwithstanding their immense variety, the ferns, as a group, are of but slight economic value.

FEROZEPUR or **FIROZPUR**, a city and district in the Punjab, British India. The city is served by the Lahore-Delhi main line of the North Western railroad. An English possession since 1835, Ferozepore has an extensive grain trade. The district of Ferozepore, through which runs the Sutlej River, is largely irrigated by the Lower Sutlej irrigation system. The principal crops are wheat, rice, maize, cotton and tobacco. Area 4,286 sq. mi. Pop. 1921, city, 54,351; district, 1,098,248.

FERRARA, a city of northern Italy, capital of the province of the same name, seat of an archbishop and of a university. Numerous palaces recall the golden period of the famous court of the dukes of Este, one of the oldest princely families in Italy. The city attained the height of its glory under Alfonso I, patron

of ARIOSTO and TITIAN. Following the death of Alfonso II, patron of Tasso, the duchy was united with the states of the Church. After a long decline Ferrara has attained new vigor through its commerce and industries, chiefly in sugar. In the center of the city is the massive citadel with four towers; nearby are the city hall and the splendid cathedral with a 12th century façade. Among the many other fine churches are San Cristoforo, Santa Maria in Bado and San Francesco containing the tombs of the Este family. The city has several beautiful squares, a museum, and a fine picture gallery, where the Ferrara school of painting is well represented. Pop. 1931, 115,883.

FERRARA-FLORENCE, COUNCIL OF, an assembly which met at Ferrara in Jan. 1438, at the summons of Pope Eugenius IV for the purpose of healing the schism between the Eastern and Western churches. Alarm over the steady advances of the Turkish armies which were threatening the Byzantine Empire had prompted John VI Paleologus to make proposals for reunion in order to receive military aid from the West. The subsequent convocation of the Council of Ferrara to consider the question of union followed upon a complete break between the Pope and the Council of Basle, which had been convoked by Martin V, in 1431, but which proved to be revolutionary and was henceforth considered schismatical. Early in Feb. 1438, about 700 Greeks, led by the Emperor John Paleologus, Bessarion, archbishop of Nicaea, and Mark Eugénicus, archbishop of Ephesus, arrived at Ferrara to commence negotiations. The next year, because of a plague in Ferrara, the council was transferred to Florence, where the session opened on Feb. 26, 1439. Among the questions discussed were: the procession of the Holy Ghost; the admission of the *filioque* in the Greek creed; and the primacy of the pope. A decree of union was signed on July 6, 1439, by all the delegates except Mark Eugénicus, and the bishop of Stauropolis who had fled. The agreement was formally proclaimed in Santa Sophia in 1452, but was repudiated by a Synod of Constantinople in 1472.

FERRARESE SCHOOL OF PAINTING, a group of painters of Ferrara, Italy, who came into prominence in the second half of the 15th century under the patronage of the d'Este family. Members of the school were noted for their naturalistic tendencies, good drawing and their knowledge of perspective; color was their chief deficiency. Cosimo Tura was the founder of the school. He worked on the elaborate frescoes in the great hall of Schifanoia Palace, although the author of the design was his pupil, Francesco del Cossa; the subject of the design was the twelve months of the year, represented in signs of the zodiac and allegorical figures. Domenico Panetti, another pupil of Tura, shared in the painting of this enormous mural decoration. There was a close connection between the Ferrarese and Bolognese schools due to the tangled political situation (see BOLOGNESE SCHOOL). Artists from one city were attracted to the other by inducements held out by art

patrons of the reigning houses. Francesco Francia, Lorenzo Costa and Timoteo Viti were among those who found greater encouragement in Bologna. In the 16th century the Ferrarese School reached the height of its glory in the great colorist and portrait painter, Dosso Dossi.

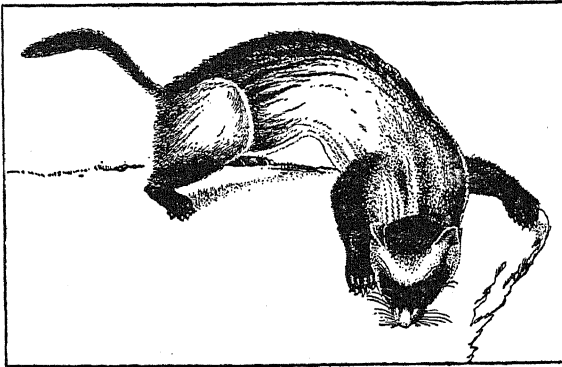
FERRARI, PAOLO (1822-89), Italian dramatist, was born at Modena, Apr. 5, 1822. Disciple of ALEXANDRE DUMAS fils and ÉMILE AUGIER, Ferrari started his dramatic career by writing historical comedies. A good example of this aspect of his work is *Il Codicillo*, 1847. He is best known for the social comedies that occupies the latter half of his career. Examples are *Cause ed Effetti*, *Due Dame* and *Il Duello*. Ferrari has been known as the most fertile of the Italian comedy writers of the last half of the 19th century. He died at Milan, Mar. 9, 1889.

FERREIRA, ANTONIO (1528-69), Portuguese dramatist, was born at Lisbon in 1528, of noble parents. Destined for a judicial career, Ferreira studied law at Coimbra, also devoting himself passionately to Greek literature, and eventually becoming professor of Greek at his university. Steeped in classical literature, his writings are so modeled on the classics that he is called the Portuguese Horace. His best known drama is *Inez de Castro*, and his verses, *Poemas lusitanos*, are important in the literary history of Europe. He died at Lisbon in 1569.

FERRERO, GUGLIELMO (1871-), Italian historian and publicist, was born at Portici, Italy, on July 31, 1871. At a comparatively early age he became a journalist. After traveling widely, he began the establishment of a literary reputation by the publication of *L'Europa giovane* and *Il Militarismo*. Turning to Roman history, he published in 1902 his *Greatness and Decline of Rome*, by which he made himself famous among general readers. During the period of Italian neutrality in the World War he vigorously supported the Allies, and argued for Italian participation in the war on the side of the Allied Powers. In the post-war period he published a number of articles and several books both in Italy and other countries, the general theme of which was a warning of the impending danger to the world at large and to Italy. One of his books was published in English in 1924 under the title *Four Years of Fascism*.

FERRET (*Mustela putorius*), an animal of the weasel family, generally regarded as a domesticated albino pole-cat. Its body is about 14 in. long and its tail about 5½ in. long. Its fur is of yellowish-white color and its eyes are red, owing to lack of pigmentation. It is extremely sensitive to the cold and its health depends on the preservation of a suitable temperature. It appears to have come originally from southern Europe. The ancient Romans were familiar with ferrets and, like the moderns, used them for catching mice. They are also used to-day for ratting and hunting rabbits, being extremely aggressive in attack, and frequently becoming intensely excited when in pursuit of their prey. Partial domestication does

not curb their natural ferocity and they have been known to attack and even kill infants. They are also liable to attack poultry, being able to kill a fowl with a single bite in the neck. Ferrets breed twice a year, the mothers sometimes devouring their offspring.



FERRER

FERRIS, WOODBRIDGE NATHAN (1853-1928), American educator, was born in Spencer, N.Y., Jan. 6, 1853. He studied at the Oswego (N.Y.) Normal School and at Michigan University. From 1879-84 he was superintendent of schools at Pittsfield, Ill. In 1884 he moved to Big Rapids, Mich., where he founded Ferris Institute and became its president. While governor of Michigan, 1913-14 and 1915-16, he aroused antagonism to his administration by his methods in dealing with the striking copper miners. He was United States senator from 1923 to the time of his death at Washington, D. C., Mar. 23, 1928.

FERRO-CONCRETE. See CONCRETE; REINFORCING BARS.

FERRIMAGNETISM. See MAGNETIC INDUCTION.

FERRY, JULES FRANÇOIS CAMILLE (1832-93), French statesman, was born at St. Dié, Vosges, Apr. 5, 1832. Admitted to the bar in 1851, he became active politically as an opponent of Louis Napoleon and the Second Empire. Appointed prefect of the Seine in 1870 he governed Paris with a firm hand during the siege. He was recognized as a Republican leader, by M. Waddington, in 1879, serving first as Minister of Education and then as Minister for Foreign Affairs; he was premier 1880-81 and 1883-85. His name is chiefly associated with the education laws of 1882 which established public elementary schools and aimed to take education from the control of the religious orders. The requirement that these seek authorization to teach aroused bitter opposition on the one hand, and was acclaimed by the anti-clericals on the other. Ferry inaugurated the policy of French colonial and commercial expansion. He was responsible for the Tunis protectorate, the occupation of Madagascar, the French administration of Indo-China, and the explorations along the Congo and Niger rivers in west-central Africa. Military reverses resulting from his colonial policy caused his political defeat and he failed of

election to the presidency of the Republic in 1887, but he was elected to the Senate in 1891 and made its president in 1893. He died in Paris, Mar. 17, 1893.

FERRYBOAT. See SHIPS, TYPES OF.

FERTILIZATION, in biology, the fusion of two cells in the course of sexual reproduction, called also syngamy. In the simpler types of this process, often called conjugation, the individuals and the cells involved are alike or nearly so, but in the more highly specialized types of sexuality the cells which fuse are of two kinds, large female gametes or eggs and small active male gametes or spermatozoa. The structural and physiological differences associated with, or involved in, the formation and the functioning of these two kinds of gametes constitute sexuality.

There are two aspects of special biological significance in the consequences of fertilization. There is the immediate activation seen in the cell-divisions and growth which result in a new individual, and there is the union and association of corresponding maternal and paternal elements in the body cells of that individual.

In regard to activation, it is the general rule that gametes die unless they enter into fertilization. In relatively few plants and animals is an unfertilized egg able to develop into an embryo either naturally as in parthenogenesis or from artificial treatment. It is more frequent that cells less highly specialized than egg cells develop into embryos as in apogamy and sporophytic budding.

The union of two cells in fertilization brings their different structural elements together in one cell. The cytoplasm of the two commingle but often the sperm supplies a small amount of cytoplasm or even none. But both the egg and the sperm carry one complete set or haploid complement of chromosomes into the fusion nucleus. The union of an egg and a sperm thus gives a double or diploid cell especially in the organization of the nucleus. This condition is maintained by the division of each unit in the subsequent divisions of nucleus and cells involved in the development of the embryo. And thus the maternal and paternal sets of chromosomes associate and interact in the development of the qualities which appear in the new individual. When this dual or diploid individual prepares for further sexual reproduction special cells are produced by a type of division in which the chromosomes are redistributed and reduced in number so that the resulting cells normally contain only a single or haploid set. In animals the rule is that the cells with reduced number immediately transform into gametes which function in fertilization, and thus there is a single cycle of diploid organisms. In plants the rule is that the cells produced by reduction division become spores which grow into a generation of plants haploid in nature and often very different in appearance and habits of life from the diploid generation. The haploid generation produces gametes which function in fertilization to give rise to the diploid generation.

Fertilization and reduction divisions are hence two antithetic processes in the recurring cycles of sexual REPRODUCTION. Fertilization brings into association and interaction in the body cells of the resulting individuals two haploid sets of chromosomes carried by eggs and sperms. When these individuals produce spores or gametes the important chromosomes are rearranged and assorted into single haploid sets. The mechanisms of the two processes are correlated with the distribution, transmission, and recombination of heritable qualities throughout the generations that have appeared or that will appear. There is an immediate biparental inheritance and a remote multiparental inheritance which are important in the determination of the character of the individual, in the development of variation among individuals, and in the progress of evolution.

The specificity of the physiological reactions which operate in the early stages of the processes of fertilization prevents promiscuous hybridization. As a rule fertilization occurs most readily between the gametes of the closely related plants and animals which constitute a species. Considerable hybridization between closely related species is possible. Within various species, especially of hermaphrodites, certain types of selective fertilization operate to limit and restrict self-fertilization and also cross-fertilization between individuals that are similar in possessing certain particular units of germ plasm.

In the angiosperms there is what is called *double fertilization*. Two male gametes are produced in a pollen tube: one fuses with the egg cell in the ovule to give rise to an embryo, the other fuses with two other nuclei, which are sister cells of the egg cell, and from the resulting triploid cell is developed the endosperm seen in the seeds.

Fertilization is to be considered as the most basic or fundamental process about which the numerous and diverse aspects of sexuality in both animals and plants are developed. See also CHROMOSOME; HEREDITY; HYBRIDISM; POLLINATION; SEX. A. B. S.

FERTILIZER DISTRIBUTORS include single and multiple-row machines, broadcasters, attachments for, and integral units of, grain drills, planters, transplanters and certain tillage implements. Numerous mechanical principles are employed in dispensing the fertilizer from the hopper, most of them depending to some extent on gravitational flow of the material. Usually, delivery rates vary somewhat with changing operating conditions, and difficulty is experienced in obtaining uniform and accurate dispensing at the lower rates of application and with fertilizers which do not flow freely. Proper placement of the fertilizer in the hill or row is considered an important function of a distributor when combined with seeding machines. G. A. C.

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FERTILIZERS, called also manures, materials used for enriching the soil in plant nutrients and for increasing crop yields. There are commercial, manu-

factured, chemical, and artificial fertilizers; also, chemical, and artificial manures. Distinct from these are the natural manures, that is excrements, with or without litter, of domestic animals; or such waste and by-products as street sweepings, peat, muck, marl, composts, hair and wool waste, and rape cake.

The main types of raw materials in the fertilizer industry are phosphates, nitrogen compounds and potash salts. Deposits of mineral phosphates are found in the United States, Canada, North Africa, China, Russia, certain South Sea Islands and elsewhere. Their content of calcium phosphate varies from less than 20 to more than 70%. In the manufacture of fertilizers, phosphate rock is treated with sulphuric acid. The resulting product, superphosphate, consists of a mixture of so-called *available* phosphates and gypsum. Recently developed furnace processes permit the manufacture of phosphoric acid which may be used for the production of more highly concentrated superphosphates with 45-48% phosphoric acid as against 16-18% in ordinary superphosphate.

The nitrogen compounds used in the manufacture of fertilizers include natural (Chilean) and synthetic sodium nitrate, by-product and synthetic ammonia, synthetic urea, cyanamide and various synthetic ammonium salts and nitrates. They also include such vegetable by-products as cotton seed meal and castor pomace and animal by-products as tankage, fish scrap and dried blood. Deposits of potash salts exist in Germany, France, Poland, Spain, Texas and New Mexico, Asiatic Russia and elsewhere. Feldspar, leucite, alunite, greensand marl and brines of salt lakes may be used as a source of potash. The fertilizer industry obtains most of its potash in the form of crude or concentrated potassium chloride, from Germany and France. Nearly one-fifth of the fertilizer potash in the United States is derived from brines in Southern California.

Superphosphates, nitrogen compounds, and potash salts are blended in the manufacture of mixed or compound fertilizers. The manufacturer usually guarantees the composition of his product by placing the analysis on the container. Thus a 5-10-5 fertilizer is guaranteed to contain the corresponding percentages of nitrogen, phosphoric acid and potash. The normal production of commercial fertilizers in the United States is 7 to 8 million tons annually. J. G. L.

Application of Fertilizers. In the application of fertilizers and manures to produce crops, the character, composition and condition of the soil must be considered. Virgin soils, such as prairie lands, are presumed to be illimitably rich, but continuous cropping with grain without replacement of elements removed by harvest or without a proper rotation of crops inevitably reduces fertility often below profitable production of such crops. Some crops do not seem to benefit from fertilizing on certain soils, but fail on others without it. Cotton in the rich Mississippi Delta lands does not require fertilizers but on most other lands it does. So not only the soil but the crop to be grown on it must be taken into account.

To apply fertilizers and manures intelligently, economically, profitably and safely it is necessary to consider the effects of the various fertilizing elements upon plant growth. Although more than a dozen elements are essential, most soils contain all but three in sufficient quantity to supply plant needs. The three often deficient are nitrogen, phosphorus and potash.

Potash, sold mostly as sulphate or chloride, is one of the chief elements of wood ashes. It is the fiber or plant skeleton builder. Nitrogen, the most costly element to buy, is sold in various combinations, especially nitrate of soda, sulphate of ammonia and urea. Its chief functions are to develop leaves and other green parts and to stimulate plant growth. Phosphorus, spoken of as phosphoric acid and sold as superphosphate of lime or ground phosphate rock, is the ripener of the growth produced by potash and nitrogen. All three work in conjunction and simultaneously with the other essential elements.

These elements, though not necessarily in the chemical forms mentioned, are contained in manures and fertilizers of animal and vegetable origin; for instance, cotton seed meal and dried blood, but in such materials they become available to plant use more slowly than the chemicals because decomposition must first occur. This drawback, however, is offset by their lasting qualities and by the organic matter which they add to the soil. The decaying material, called humus, exercises several important functions in addition to its release of the elements of plant growth. For instance, it supplies acids which dissolve inorganic soil materials; during rains it takes up moisture which it holds in dry periods and it helps to make soils friable and more favorable to plant growth.

Lime, though not a fertilizer, is often an important amendment to soils. Its chief functions are to make soil conditions congenial to those microorganisms that modify organic matter; to decompose vegetable and animal matter and to neutralize acid soils and render them more or less alkaline and thus make them favorable to vegetables and many flower crops. Because of this last function, however, lime must never be applied to soils in which plants such as rhododendrons and blueberries are growing or soon to be planted. These and many other plants require acid conditions in the soil and for this reason alkaline or neutral soil must be made acid before they are planted and kept so or the plants will languish and die. Materials recommended for this purpose are commercial aluminum sulphate and tannin prior to planting, and spent tanbark or shredded peat moss as mulches. M. G. K.

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FESCUE, a numerous genus (*Festuca*) of usually low slender grasses. There are about 100 species widely distributed throughout the world, especially in temperate regions, of which nearly 30 occur in North America. A few are grown as pasture or meadow grasses, as the tall or meadow fescue (*F. elatior*), native to Europe and widely naturalized in North America.

FESSENDEN, WILLIAM PITT (1806-69), American statesman, born at Boscowen, N.H., Oct. 16, 1806. Educated at Bowdoin College, he studied law and was admitted to the Maine bar in 1827. After serving in the Maine Legislature in 1831 and again in 1839 he sat in Congress, 1841-43, as a Whig, and in 1854-64 was United States Senator. Active in his opposition to slavery, he was also an important financial leader during the Civil War, and became Secretary of the Treasury in 1864. He recognized the need of funds for the war but strove diligently to maintain the finances of the country on a sound basis, with as little inflation as possible. He reentered the Senate again in 1865, and as chairman of the joint committee on reconstruction he advocated that the States which had seceded should be treated as conquered provinces. He died at Portland, Me., Sept. 6, 1869.

FÊTE NATIONALE, a term applied to two national holidays of France. Since 1880 by government authority, July 14, the anniversary of the fall of the Bastille, has been proclaimed a day of national rejoicing. The occasion is celebrated by military parades and the people hold receptions and banquets and decorate their houses with the colors of the Republic, much as the American custom on the Fourth of July. The second *fête nationale* is held on Sept. 22 in commemoration of the establishment of a republican form of government.

FÉTIS, FRANÇOIS JOSEPH (1784-1871), Belgian musician and musicographer, was born at Mons, Mar. 25, 1784. A student at the Paris Conservatoire, he returned there in 1820 as professor of theory and in 1827 became librarian, in the latter year founding the *Revue musicale* and in 1833 becoming director and royal capellmeister of the Brussels Conservatory, where he remained 38 years. His fame rests on his works dealing with musical history and criticism, which include the eight-volume *Biographie universelle des musiciens*, and the five-volume *Histoire générale de la musique*. His other works include *Traité du contrepoint et de la fugue* and *Traité complet de la théorie et de la pratique de l'harmonie*. He died at Brussels, Mar. 26, 1871.

FEUDALISM. Any system which combines a series of personal relationships with a scheme of landholding and a form of government, particularly one of a military character, may be termed a feudal system, and such systems have flourished in various parts of the world at different times, notably in Japan well on into the 19th century. But the name is usually applied to the social and political organization of western Europe during the medieval period.

Origins. It is customary to trace the origins of feudalism back to conditions prevailing under the Roman Republic and among the barbarous Germans. The Romans recognized certain special personal relationships between patron and client, in which the former gave protection and the latter offered some sort of personal devotion. There was in this Roman institution an element of social superiority on the part

of the patron. Among the Germans there existed an institution which Tacitus called the *comitatus*, a band of warlike companions who grouped themselves about the person of some distinguished warrior and followed him into battle. This was a personal relationship between social equals in which the honorable status of each was enhanced. Fighting for his leader was the duty of each warrior. Both Romans and Germans recognized that the bond holding together patron and client or chieftain and warrior was one of mutual loyalty. When in the 5th century A.D. German tribes invaded and settled in the Roman Empire these two institutions and the social ideas which they expressed tended to amalgamate into more or less common practices.

Meanwhile in the economic decay and political confusion which characterized the decline of the Roman Empire certain practices tended, in many instances, to link clientage with landholding. The senatorial aristocracy for generations had been accumulating large estates. Independent farmers often found it hard to compete with these, particularly during hard times. A common remedy for such farmers was to become clients to some great landowner by a process of commendation whereby they became his men, surrendered the title to their land to him, and received the right of continued use of their land under their patron's protection. Landless men might similarly commend themselves to the landowner and be granted the use of land in consequence.

During Merovingian and Carolingian times, a period of about 400 years, from the 5th to the 9th centuries, semi-feudal conditions existed. Some of the elements of feudalism were well developed and widespread, but they were not the only means whereby society was organized. In this period the term vassal came into use as a name for a faithful military follower who commended himself to some magnate. Since the Germans had settled down in the Roman Empire, landholding had become more important and the example of the great estates of the senatorial aristocracy was one which could be imitated. There was not yet a necessary connection between vassalage and landholding, but more and more frequently they came, in practice, to be linked. An important step was taken when Charles Martel required the Church to grant the use of Church lands to Charles's vassals in order to enable the latter to meet the costs of fighting on horseback against the Moslems. This shows a tendency to link such landholding with military services. In respect to jurisdiction the Frankish rulers, often out of respect for religion, granted to monasteries, which owned considerable land, immunity from the king's officials. This meant that the monastic owners became the king's officials on their own land, holding court, making financial collections and calling out the warriors. This privilege could also be extended as an act of royal favor to lay landowners, or the latter could sometimes usurp this power.

Politico-Social System. The real feudal system, indeed, is the product of the period of political con-

fusion which came with the break-up of Charlemagne's empire. Every freeman, needing protection, entered into vassalage to someone greater than himself, and the King used such relationships as the means of securing the military service due from freemen. Such relation had now come to imply landholding as a necessary means of support, and in the face of Carolingian impotence the landowners usurped the privileges of immunity in widespread fashion, or the local royal officials appropriated for their own use the land attached to their office and exercised in their own name the authority formerly wielded for the king. When the old practices, which had previously existed separately and occasionally, had become joined and universalized, and when they had become hereditary and recognized as a legal form of government the feudal system had come into existence.

The central feature of this system was the fief, which has been described as a piece of land granted by a hereditary owner, the lord, to an hereditary holder, the vassal, in return for honorable services usually of a military character. The fact that these services were honorable indicates that feudalism was really confined to the nobility. Ignoble service, such as useful manual labor, was performed by serfs, who formed probably nine-tenths of the population. The relationship between lords and vassals was one of mutual loyalty based upon oaths of fidelity and established by the ceremony of homage. The lord assured to his vassals the enjoyment of their fiefs, protection to their persons and honor, and the guarantee of justice. In return each vassal was obligated to fight for his lord; to give the lord counsel, i.e., to assist him in his government; and to resort to the lord's court of justice either to act with the lord as a judge or to answer to complaints. In the latter case the vassal had the right of being tried by the court composed of his fellow vassals, a right which is the origin of trial by one's peers.

Financial obligations of vassal to lord were limited to unusual occasions. If a lord were burdened with some extraordinary expense it was right that his vassals should make contributions. Such contributions were called aids. They came, by custom, to be limited to certain specific events, namely when the lord knighted his eldest son, when he married his eldest daughter, or when he was captured and had to pay a ransom. In some places he could demand an aid when he went on a crusade. In MAGNA CARTA will be found the assertion that only on the three first mentioned occasions can an aid be claimed unless the vassals had given their consent, a feudal right which contained the germ of the Parliamentary control over taxation. A vassal when succeeding to his father's fief paid a sum, called relief, in acknowledgment of the lord's ownership of the fief. If the vassal were a minor he became a ward to his lord and the latter administered the fief during the minority, sometimes using the opportunity to exploit the fief to his own advantage. Women were regarded as perpetual minors; but their husbands could perform their feudal duties

for them. It was therefore the lord's right to choose husbands for such wards, a right which could easily be used to get funds.

It will be observed that the lord with his vassals forms a small state, organized as an army, a council and a court. The system was one responding to the needs of a community in which land was the chief form of wealth, and in which each locality was, in large measure, both politically and economically self-sufficient. There was only a limited use of money, and, unlike modern taxes, the contributions for the support of the state were mostly in service, the amount of which came to be fixed by custom. Governmental functions were in fact parcelled out to the fief-holders, each exercising jurisdiction over the people who lived on his land. In order for each lord to maintain himself he refrained from granting part of his land to vassals, retaining it himself, having it worked by serfs, and living off the produce. This was the domain, the lord's land, from the Latin *dominus*. If a vassal failed to live up to his obligations his fief might be declared forfeit and the lord might resume possession provided he was sufficiently powerful to do so. If a vassal died without heirs the fief reverted to the lord as owner. This was called escheat. Theoretically feudal society formed a pyramid, with the king at the apex. The latter, however, had feudal relations only with his own vassals who owed him feudal duties. With their vassals the king had no direct relations. The feudal king was not a national sovereign, he was merely the top of a contractual system.

While the statement that feudalism served to hold together society in a period of dissolution may be accepted, it is equally true that the epithet "organized anarchy" is one which the system well merited. It will be seen that every individual in the system is both a lord and a vassal except the king at the top, who is only a lord, and at the bottom the holder of a fief which was so small that he had to use it all for his own domain, who was only a vassal. The effective working of the system depended upon the fidelity of vassals to lords and vice versa. The personal bond had to be renewed by the ceremony of homage and by oaths of fealty whenever any one in the feudal hierarchy died and was succeeded by his heir. Any failure or refusal to perform feudal obligations or to renew the personal bond would throw the system out of gear, with an appeal to force as the only remedy. To succeeding generations who had been in long continued possession of a fief, the obligations of vassalage often came to be retention of the family property, to be evaded when occasion warranted, and to be performed in as restricted a fashion as possible. The situation became further complicated by the fact that inheritance would often bring to the same vassal several fiefs each with a different lord. In consequence feudal history is a dreary story of petty but brutal struggles of lords against recalcitrant vassals. Furthermore since the vassals of different lords had no obligations toward each other they were free to fight for any reason which they saw fit. The right of

private war was regarded as a privilege of the feudal noble, often necessary for the defense of his honor and usually employed for the satisfaction of his ambition and the gratification of his taste for adventure. The Church attempted to curb feudal warfare by proclaiming the "Peace of God" and the "Truce of God" backed up by religious sanctions, but with only limited success. It was only with the increase of royal power that an authority was found strong enough to require the peaceful settlement of feudal disputes and to protect the weak from the depredations of the strong.

Medieval history is largely a record of struggle between kings and the feudal nobility, with varying results in different countries. As land ceased to be the only important form of wealth and as warfare became more complicated and expensive the feudal system became inadequate and weak. It was an anachronism in an age of money and gunpowder. In France and Spain the king eventually triumphed over the nobility. In England the feudal barons, by gaining the cooperation of the other classes, and by utilizing Parliament, itself originally a feudal institution, succeeded in putting considerable limitation on the royal power but without perpetuating feudalism as a system of government. In Germany feudalism ran riot, splitting the state into many fragments and thereby delaying national unification for generations. Even in France where the monarchy asserted itself in the political field, the effects of the feudal system in creating an aristocratic landholding class with social privileges and with some remnants of local jurisdiction remained until swept away by the French Revolution, while in England the influence of feudalism upon the laws of land inheritance lasted into the 20th century.

R. A. N.

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FEUILLANTS, a club of moderate Liberals during the life of the Legislative Assembly, Oct. 1791–Sept. 1792, in the period of the French Revolution. An outgrowth of a club founded by Lafayette, it suffered from trying in part to follow his dubious course of double dealing and in part from the nature of its position midway between the extreme republicans and the thorough going monarchists. The insurrection of Aug. 10, 1792 was the ruin of the Feuillants. The name survived as a term for cowardly compromisers.

FEUILLET, OCTAVE (1821–90), French novelist and playwright, was born at Saint-Lô, Normandy, Aug. 11, 1821. He early won a literary reputation in Paris, but was obliged to spend most of his young manhood as companion to his father, a nervous invalid. He continued to write, however, publishing *Bellah*, and a play, *La Crise*, in 1852, *La Petite Contesse* and *Dalila*, in 1856, and his popular novel, *Le Roman d'un Jeune Homme Pauvre*, in 1858. Freed from duty by his father's death, he now took up a much fêted life in Paris, but, in delicate health himself, he returned to Saint-Lô in 1862, and later com-

bined writing with travel. *Monsieur de Camors*, 1867, and *Julia de Trecoeur*, 1872, are among his best works. His plays were undistinguished, but his novels possessed reality, and his style, rhythm and vigor. Feuillet died in Paris, Dec. 29, 1890.

FEVER, a condition of the animal body in which the temperature is higher than normal. Our conception of fever is formed from the reactions observed in infectious diseases, such as typhoid, pneumonia, malaria, etc. Associated with the elevation in body temperature, there are changes not only in the heat-regulating mechanism, but also in metabolism, circulation and respiration. In addition, other alterations occur, such as those noted in the chemical and physical structure of the blood and tissues. All of these variations make the condition complex and difficult to understand.

To recognize fever it is necessary to know the normal temperature which varies with different animals. In birds, the normal mean temperature is between 104° and 107.6° F., and may be found as high as 110° F. Most mammals have a normal temperature lower than that of birds but higher than that of man. The normal temperature of the human body is considered 98.6° F. (37° C.), but it varies in different parts of the body and with the time of day. For instance, there may be as much as one degree (Fahrenheit) difference between the oral and rectal readings and almost two degrees of variation during the day, from the minimum early in the morning to the maximum late in the afternoon. A reversal of this diurnal variation usually occurs in the case of individuals who work at night and sleep during the day.

The classification of fever is based upon its degree of elevation, its fluctuations, and the severity of the reactions of the body, all of which are dependent upon the causative factor.

Normal Regulation of Body Temperature. The temperature of the body is dependent upon the relation between the amount of heat produced and the amount of heat eliminated. Heat is produced in the body by the various metabolic processes and is eliminated through the skin and lungs by radiation, conduction, and evaporation. Muscular activity increases heat production. As a result, the cutaneous blood vessels dilate and increase the radiation and conduction of heat through the skin. The skin perspires and respiration increases, causing further dissipating of heat by evaporation. In the case of violent exertion, the normal regulation is insufficient and the temperature of the body becomes elevated. Upon exposure to cold, the mechanism is reversed. The cutaneous vessels contract, the skin becomes dry, respiration is retarded, radiation, conduction, and evaporation are diminished, and heat is retained. If the exposure is extreme, heat production is increased by muscular activity, such as occurs with shivering, and the normal body temperature is maintained.

Causes of Fever. The simplest type of fever is that caused by a disturbance in the heat-regulating mechanism. It has been noted that fever may occur

following excessive muscular activity. If the physical processes of radiation, conduction, and evaporation are interfered with, as in heat-stroke, the temperature becomes elevated, and may remain so for days or weeks, due to a temporary disturbance of the heat-regulating mechanism. Some of the highest temperatures recorded (110°-112° F.) have been in cases of heat-stroke.

Excessive loss of water by prolonged exposure to a warm, dry air disturbs the heat regulation of the body, preventing elimination by evaporation, with resulting fever.

It has been quite definitely established that the heat-regulating mechanism is controlled by a heat-regulating center in the brain. In animals, stimulation of certain areas in the brain causes an elevation of temperature.

The commonest type of fever is that found in the infectious diseases, such as typhoid, malaria, pneumonia, and many others. A similar type may be produced by the injection into the body of living or dead bacteria, of various foreign proteins and certain inorganic salts, as for instance, sodium chloride.

Mechanism. The mechanism by which fever is produced in such conditions as excessive muscular exertion, heat-stroke and dehydration is easily understood, as is that by which fever is produced through the stimulation of the so-called heat-regulating center of the brain. Fever in the infectious diseases is more complicated. The heat production is increased, particularly at the time of a chill, and since heat elimination does not keep pace with this production, the temperature rapidly rises. When the temperature becomes stationery, heat production and elimination become proportionate. It has been suggested that some substance forms in the body and acts upon the heat-regulating center to cause this condition.

Effects of Fever. In the infectious diseases, fever is so closely associated with the infectious process that it is difficult to distinguish between the effects of fever and the effects of infection or intoxication. In heat-stroke, however, we observe primarily the effects of fever. The respiratory and pulse rates are increased, the patient is lightheaded, dizzy, and possibly delirious. The appetite is poor, and nausea and vomiting sometimes occur. The metabolism is increased. Acidosis may be present. There is a retention of water and of sodium and calcium salts. At the onset, these signs and symptoms are due primarily to fever, but later are caused also by the intoxication resulting from the elevation of body temperature. In experiments on rabbits, the temperature has been slightly elevated for periods of weeks and months without causing any clinical disturbance. High temperatures, however, produce many of the symptoms previously mentioned.

Significance of Fever. Since the beginning of clinical medicine, it has been a question whether fever is harmful, of no particular significance, or possibly beneficial.

Certainly the high temperature in heat-stroke is not

useful but is harmful, and may even cause death. This observation has been confirmed by experimental work on animals, showing that a high elevation of temperature produces severe intoxication, while a slight one is apparently harmless.

There are certain simple methods of reducing the body temperature in fever, such as the use of cold sponges or the administration of ANTIPYRETIC drugs (ASPIRIN, ANTIPYRINE, PHENACETINE, etc.). Comparative studies of patients receiving such treatment and those without it indicate that there is no definite difference in the progress of the infection.

Recently, evidence has accumulated which suggests that the fever of infectious diseases is of value. It has been shown that the immune substances which develop in the blood and protect the animal against infection are produced more rapidly at a high temperature than at a normal one. Also, certain bacteria which thrive at the normal temperature do not grow at the temperature found in fever. Furthermore, the metabolism of the body is increased by fever, making it more active in its fight against the invading organism. See also CHILDREN, DISEASES OF: Fever in children. N. P.

FEVERFEW (*Chrysanthemum Parthenium*), a bushy, strong-scented garden perennial of the composite family. It is a native of Europe which has become sparingly naturalized from New Brunswick to California. The plant grows about a foot high, bearing smoothish divided leaves and clustered flower-heads composed of white rays surrounding a yellow center. Various dwarf forms, with curly yellow foliage, are used for edgings.

FEW, WILLIAM PRESTON (1867-), American educator, was born at Greenville, S.C., Dec. 29, 1867. He graduated in 1889 at Wofford College and took his Ph.D. at Harvard in 1896. From 1896-1910 he was professor of English at Trinity College, Durham, N.C.; dean from 1902-10, and in the latter year was elected president. In 1924 the name of the college was changed to Duke University.

FEWKES, JESSE WALTER (1850-1930), American ethnologist, was born at Newton, Mass., Nov. 14, 1850. After graduating in 1875 at Harvard, he studied zoology at the University of Leipzig, and in 1881 returned to Harvard where he was for eight years an assistant in the museum of comparative zoology. Until 1885 he worked under Alexander Agassiz. During 1890-94 Fewkes edited the *Journal of Ethnology and Archeology*, and in 1895 became associated with the Bureau of American Ethnology at Washington, of which he was chief during 1918-28. He directed the Smithsonian Archeological Expedition to Arizona and wrote extensively on ethnological subjects, including a report on the ceremonies of the Moqui Indians. In 1908-09 he had charge of the excavations at Casa Grande, Ariz. He died at Forest Glen, Ind., May 31, 1930.

FEZ, Africa, the capital of French Morocco. It is situated in a valley 100 mi. east of the Atlantic Ocean. Hills dotted with orchards of fruit trees and olive

gardens surround it and provide a picturesque setting. For over a thousand years Fez has been one of the holy Muslim cities and has been particularly celebrated as an educational center.

The houses of the town are high and often constructed over the gloomy and constricted streets. Commercially, Fez is the nucleus of the Barbary trade, the chief exports being gold, fez caps, pottery and ivory, and the principal imports being the commodities of European manufacture and the yields of tropical countries. The treaty establishing the French protectorate in Morocco was signed at Fez in 1912. Pop. 1931, 107,843.

FIACRE, ST., French hermit of Irish descent, was born in Ireland in the 7th century. Very little is known about his early life except that he crossed to France and was received by the Bishop of Meaux who furthered his desires of living a solitary life in the neighboring forest. Here he gradually gained a reputation for holiness and pilgrimages from great distances were made to his abode. His charity and kindness to the poor are especially remembered. St. Fiacre died about 670, and his festival is celebrated on Aug. 30. The French carriages named after him derive their name apparently from the fact that the man who first introduced hired vehicles named his establishment after St. Fiacre.

FIAT MONEY, a circulating medium without intrinsic value, dependent upon the edict of a government for its acceptability, since it is not redeemable in coin or specie and has no reserve behind it. Such was the issue of greenbacks by the U.S. Treasury during the Civil War, and many of the issues of European countries during the World War. A government can never succeed in making its citizens accept fiat money at the same value as specie, and for that reason the history of any issue of fiat money has been a record of depreciation more or less rapid according to circumstances. The American greenback fell at one time to about one-third of its face value in gold, but rose rapidly to par when it became evident that the Treasury intended to redeem the greenbacks in gold.

Theoretically it is possible for fiat money to be managed in such a way that it will not depreciate, that is, that the level of prices will not rise. If the government were to limit the amount of such money to the usual per capita circulation, there would be no occasion for depreciation. But such money is seldom issued except in a crisis. When the Treasury is faced with war or bankruptcy, and when once begun, it is almost impossible to stop further inflation. The German paper mark and the Russian rouble, both of which were eventually repudiated, furnish recent evidence of the danger of fiat money. See FIDUCIARY ISSUE; TREASURY NOTE. B. H. B.

FIBER BOARDS, industrial products half-way between PLYWOOD and PAPER, in which the wood is reduced to fiber form and re-assembled in large sheets. Masonite is produced by exploding chips and small blocks of yellow pine under 1200 lbs. steam pressure,

floating the resulting fibers into thick sheets, which are squeezed partly dry between rollers and are ultimately dried and compressed between steam heated platens. It is made in various densities for different uses. Insulite is also made from wood fibers which are reduced to fiber form by chemical processes and re-assembled in large thin sheets. Celotex is a thin sheet aggregated from the fibers of sugar cane stalks. While not as strong as the wood pulp in sheet form, it has important heat insulation and acoustic properties. Upson board is wood fiber reduced by chemical processes, but made ultimately into more refined forms suitable for interiors, ceilings and wall panels. Other fiber boards are known by the trade names, Beaver-board, Cornell board and Maftex. T. D. P.

FIBER PLANTS, plants yielding valuable fibers, many of which are of world-wide use. The commercially important fibers are from three sources: (1) leaf-fibers, such as sisal, New Zealand hemp, Manila hemp, bowstring hemp and many others; (2) stem fibers, such as ramie, piassava, hemp, flax (linen), esparto, and numerous native cordage fibers; (3) seed fibers, the chief of which are cotton and kapok.

In addition to these there are many fiber plants used whole, as in the making of matting or Panama hats. And some are used extensively for paper making. In the latter the plant is retted, or otherwise chemically treated for the removal of its useful constituents, sometimes cellulose but often the fiber itself. *See also* FLAX; HEMP; SISAL HEMP; NEW ZEALAND FLAX; ABACA; RAMIE; ESPARTO; GRASS; KAPOK; COTTON. N. T.

FIBER TESTING. *See* TEXTILE TESTING.

FIBROUS PLASTER. *See* GYPSUM PLASTER.

FICHTE, JOHANN GOTTLIEB (1762-1814), German philosopher, was born May 19, 1762 at Rammenau. After spending several years as a private tutor, he was deeply influenced by IMMANUEL KANT and became professor of philosophy at Jena in 1794. Accused of atheism, he resigned in 1799 and for 10 years experienced a bitter struggle. When the new university was founded at Berlin, he served as its rector from 1810-12. In 1794 Fichte published his chief work, *Groundwork of all Scientific Knowledge*. His popular *Addresses to the German People*, delivered in Berlin in 1807, did much to inspire them and to instill in them the spirit of unity. He died at Berlin, Jan. 27, 1814.

Fichte's philosophy is aptly described as an ethical idealism. He belongs to the romanticists who were trying to lay bare by a transcendental method the ground principle of the universe. For Fichte the universe was moral to the core. This was the nature of the Absolute. The obstacles which nature everywhere presented were but means whereby the moral self was realizing himself.

FICINO, MARSILIO (1433-99), Italian philosopher, was born at Florence, Oct. 19, 1433. He studied at Florence and Bologna and was selected by Cosimo de' Medici to translate the works of Plato into Latin. He became a confirmed Neo-Platonist and translated not only Plato but also Plotinus and the other Neo-

Platonists. The work in which he gave completest expression to his system of thought is *Platonic Teaching Concerning Immortality*, published in 1482. The essence of his insistence here is that Platonic philosophy is divinely fitted to serve as the basis of religion. Ficino's *Letters* reveal intimacy with a wide circle of eminent men. He died at Florence, Oct. 1, 1499.

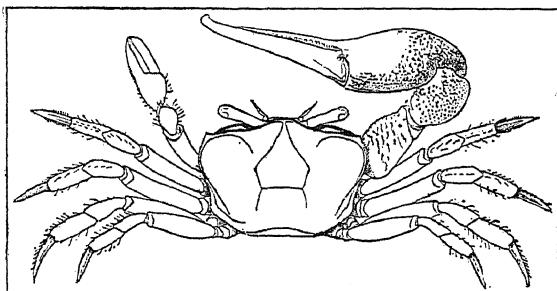
FICKE, ARTHUR DAVISON (1883-), American poet, was born at Davenport, Ia., Nov. 10, 1883. He was graduated from Harvard in 1904, and studied law and taught English at the University of Iowa, being admitted to the bar in 1908. During the World War he served in France from 1917 to July 1919, with final rank of lieutenant-colonel. As a poet, he is best known for his sonnets. Among his many volumes of poetry are *From the Isles*, *The Earth Passion*, *Mr. Faust*, *Sonnets of a Portrait Painter*, 1922, *April Elegy* and *Mountain Against Mountain*, 1929.

FICTION, in its broadest interpretation, that branch of literature embracing all narrative forms in which the incidents, characters and scenes are partly or wholly imaginary. Its origin is based on the universal human appreciation of a "story" and for this reason its beginnings are untraceable. Apparently some form of fiction has always existed, whether in the guise of the Homeric legends, the fables of Æsop, the parables of the New Testament, medieval lays and *chansons de geste*, or the scandalous little tales of the Italian writers of the 13th and 14th centuries. Each and all were imaginary narratives, forerunners of the true NOVEL.

FICUS, a very numerous genus of woody plants of the mulberry family, including the cultivated FIG (*F. carica*) and many other useful and ornamental plants. There are about 800 species, found in tropical and subtropical regions, especially in the East Indies and Polynesia. Two species are native to southern Florida. About 20 species, grown as pot and tub plants in the North, are sparingly planted in the open in southern California and Florida. The genus comprises trees, shrubs and woody climbers. Several are epiphytic, germinating in the bark of a tree and sending down aerial roots which gradually grow together, forming, when they have strangled the host tree, a stout independent trunk. The group is characterized by its peculiar fruit, an oblong or pear-shaped syncarp bearing on its inner walls an immense number of minute flowers, fertilized usually by special insects. Besides the common fig, the genus includes the India rubber tree (*F. elastica*), the BANYAN (*F. benghalensis*), and the PEEPUL or botree (*F. religiosa*). *See also* RUBBER.

FIDDLE-NECK (*Phacelia tanacetifolia*), a stout, somewhat bristly annual of the water-leaf family, native to California and sometimes cultivated for its attractive early-blooming flowers. The erect, slightly branched stems, about 3 ft. high, bear much-divided, fern-like leaves and small, bell-shaped, lavender or blue flowers, clustered in somewhat coiled spikes.

FIDDLER CRAB, the popular name for members of a genus (*Gelasimus*) of crabs, in which the male has one claw enormously larger than the other. The big claw is pictured as his fiddle, and the small one, his bow. Fiddlers live along the coasts of the Atlantic and Indian oceans, usually very close to the



FIDDLER CRAB
Uca pugillator

water. Three species are found in the United States. They dig burrows in the sand for houses, and eat minute plants and animals. The male uses his big claw, which may be longer than his body, as a weapon in fighting, as a signal flag to attract the female and as a door to stop up his burrow. *See also* CRAB.

FIDELIO, an opera in two acts by LUDWIG VON BEETHOVEN, libretto by Bouilly, translated and revised by Sonnleithner and later emended by Treitschke and von Breuning, the latter condensing the original three acts into two acts; première, Vienna, 1805, in the original version (first revision, 1806, second revision, 1814), London, 1832, New York, 1839, Paris, 1860. Save for the fragmentary *Vestas Feuer*, the opera is Beethoven's sole excursion into the field of music-drama. He found unusual difficulty in getting a libretto which satisfied both him and the public, and his general dissatisfaction and uncertainty while exploring the dramatic field are reflected in the endless musical sketches he made for the work as well as in the four separate overtures he composed for it. Of these four the *Fidelio* overture in E major, composed in 1814, was finally chosen for the opera. It is infrequently performed.

A Spanish nobleman named Florestan has run afoul of the governor of a medieval prison, Pizarro, who casts the former into a dungeon to forward his private ambitions, at the same time spreading the report that Florestan is dead. Suspecting foul play, Florestan's devoted wife Leonore disguises herself as a man and obtains employment in the prison under Rocco, the chief jailer. She assumes the name of Fidelio. Although Jacquino, the prison turnkey, is in love with Marcellina, the jailer's daughter, the latter proceeds to fall in love with Fidelio who dares not reveal her sex. As Rocco himself favors the match, Fidelio soon gains the jailer's confidence and discovers what she had suspected—that her husband Florestan is alive, a captive in the deepest dungeon in the prison. At this juncture the prime minister

of Spain, Don Fernando, announces his intention of inspecting the prison. Fearing that his false imprisonment of Florestan will be discovered, Pizarro decides to have the man killed. Rocci is instructed to commit the murder. Refusing, he is ordered to dig a grave, and Fidelio has the gruesome task of assisting. Pizarro thereupon enters the vault, intending to slay Florestan himself, when Fidelio interposes her own body between her husband's and Pizarro's raised dagger, revealing her identity and covering the would-be murderer with a pistol. At the same instant a trumpet call blares forth, announcing the arrival of the prime minister, and Pizarro is apprehended without delay.

FIDUCIARY ACCOUNTING. By reason of positive legislation or in order to protect himself from any possible attack upon his stewardship, a Trustee must keep proper accounts and render periodical statements as required by the court in the case of testamentary trusts or court trusts, and as agreed upon in the case of living trusts. (*See* TRUST COMPANY.) In the cases of a testamentary trust, the opening entries on the books consist of the amounts of property described and classified in the inventory of the deceased person's estate. This inventory is filed with the probate court, and the account classification of the fiduciary accounts may conveniently correspond with the classification of property in the inventory. From this time on, the stewardship of the trustee, whether the trustee is an individual or a corporation, becomes a matter of record in the fiduciary accounts which must be kept by the trustee. These entries describe in detail what changes occur in every asset in the property under the care of the trustee. The same principles apply to the fiduciary accounting of executors or administrators of wills and guardians of the estates of minors, incompetents or other dependents.

J. G. S.

FIDUCIARY ISSUE, paper money issued against, or secured by, government obligations. The outstanding examples of such issues are the national bank notes of the United States, and a part of the issue of the Bank of England. A national bank in the United States wishing to issue notes must deposit with the Comptroller of the Currency in Washington, an equal amount of government bonds, plus a 5% redemption fund. These notes, although more satisfactory than the old state bank notes which they superseded, were inelastic and inadequate for the needs of business, and have declined in relative volume since the establishment of the Federal Reserve System.

From time to time the Bank of England has made advances to the English treasury in the form of notes, collateralized by government securities. Before the World War the amount of such notes was £18,000,000; since the return to the gold standard in 1926, and the combining of treasury notes with Bank of England notes, the amount has stood at £260,000,000.

B. H. B.

FIEF, term for a feudal estate. *See* FEUDALISM.

FIELD, CYRUS WEST (1819-92), American capitalist and promoter, was born at Stockbridge, Mass., Nov. 30, 1819. After carrying on a prosperous paper business with a brother, and then going bankrupt with another partner, he became interested in the idea, first of a telegraph across Newfoundland, and then of a transatlantic telegraph cable, and in 1854 he organized the New York, Newfoundland, and London Telegraph Company, being joined by Peter Cooper and several other friends. In 1856, with John W. Brett and Sir Charles Bright, he organized the Atlantic Telegraph Company, with guarantees from the American and British governments, and from then on he devoted himself to the realization of his project. After several failures the cable was successfully laid, and Field received a gold medal from Congress and other honors at home and abroad. He died in New York City, July 12, 1892.

FIELD, DAVID DUDLEY (1805-94), American jurist, was born at Haddam, Conn., Feb. 13, 1805. He was admitted to the bar in 1828 and practised in New York City until 1885. In 1847 he became a member of a commission to reform the legal practice of the State and drew up a *Codes of Civil and Criminal Procedure* which were legally adopted. In 1857 he prepared a codification of the entire province of American law which was used as a model legal structure by the majority of the States. He died in New York City, Apr. 13, 1894.

FIELD, EUGENE (1850-95), American poet, was born at St. Louis, Mo., Sept. 3, 1850. He attended successively Williams and Knox colleges, and the University of Missouri, but took no degree. Beginning journalistic work in 1873, he was with several papers, finally joining the *Chicago Daily News*. He remained with this paper until his death, contributing to it much of his verse. Field's best work was perhaps for, or about, children; his most popular poem, *Little Boy Blue*, appeared in 1888. Among other volumes of verse were *A Little Book of Western Verse*, *With Trumpet and Drum*, *A Second Book of Verse and Lullaby Land*. Field died at Chicago, Ill., Nov. 4, 1895.

FIELD, MARSHALL (1835-1906), American merchant, was born at Conway, Mass., Aug. 18, 1835. He entered the dry-goods business at Pittsfield, Mass., before he was twenty and in 1856 he became clerk and traveling salesman for the wholesale dry-goods house of Cooley, Wadsworth and Company, of Chicago. In 1862 Field was admitted as junior partner, after serving one year as general manager. Later Potter Palmer financed a dry-goods business for Field and Levi Z. Leiter, which was known as Field, Palmer and Leiter. On the retirement of Palmer and Leiter, the name was changed to Marshall Field and Company. The business of this organization so developed that it became the largest wholesale and retail concern in the world. Marshall Field died at New York, Jan. 16, 1906.

FIELD, STEPHEN JOHNSON (1816-99), American jurist, was born at Haddam, Conn., Nov.

4, 1816, brother of Cyrus West, David Dudley and Henry Martyne Field. He began legal practice in New York City, but moved to California in 1849, where the following year he was elected to the first legislature of that State. In 1857 he was appointed a justice of the Supreme Court of California, becoming Chief Justice two years later. In 1863 President Lincoln appointed Field to the United States Supreme Court, where he served with distinction for 34 years. He was strongly opposed to slavery. Following one of his decisions, he narrowly escaped assault in 1889 by former Judge David S. Terry. He died at Washington, D.C., Apr. 9, 1899.

FIELD, DYNAMO-ELECTRIC, a part of a DYNAMO ELECTRIC MACHINE, comprising a series of INDUCTION COILS wound on iron cores or poles, which establishes the magnetic flux that in a generator is cut by the ARMATURE conductors; or which, in a motor, exerts a force on the armature causing the rotor to revolve. When the field winding is made to carry the main current by being connected in series with the armature, it is termed a "series field." When the winding is connected in parallel with the armature so that it carries only a small portion of the total current of the machine, it is called a "shunt field." This term is also frequently used when the winding is excited from an external source, although the more correct term in such cases is "separately-excited field." Sometimes shunt and series windings are employed together, the two functioning either co-operatively or differentially, the system being termed a "compound field." In some machines the field embodies, in addition to the regular winding, small poles, termed *interpoles* or commutating poles, located between the main poles (see figure) and serving to effect sparkless commutation, i.e., sparkless transfer of current between the commutator segments and the collecting brushes. The windings of these interpoles are usually connected in series with the armature and are so positioned with respect to the brushes that their flux acts to assist the reversal of current flow in the armature conductors as they undergo commutation, thus preventing a spark from jumping from the edge of the commutator segment to the edge of the brush. A machine equipped with commutating poles is termed an "interpole machine." H. M. H.

FIELD ARTILLERY. See ARTILLERY.

FIELDFARE, an Old World species of thrush (*Turdus pilaris*) found widely in Europe, nesting in northern Europe and Asia, and wintering from England to northern Africa. It is the most gregarious of the thrushes, migrating in large flocks and often breeding in colonies of 100 or more in birch woods and orchards. It has the general size and appearance of the song thrush but has a gray head and rump and chestnut back.

FIELD GLASS. See BINOCULAR INSTRUMENTS.

FIELDING, HENRY (1707-54), English novelist, was born Apr. 22, 1707, at Sharpham Park, near Glastonbury, Somersetshire. He attended Eton College and later studied law at Leyden, Holland. His formal

education completed, he entered into the social life of London with the tremendous gusto which marked his every action. The small yearly income due to him from his father was paid irregularly, and of necessity Fielding turned to the drama as the most lucrative form of writing; perhaps he hoped to make such a fortune as had rewarded John Gay for his *BEGGAR'S OPERA*. He produced several comedies of a racy, epigrammatic type, patterned mainly after Congreve; these include *TOM THUMB*, *The Mock Doctor*, *The Miser* and *The Historical Register of 1736*, none of which is greatly important. About 1735 Fielding married Charlotte Cradock of Salisbury, to whom he remained devoted till her death in 1743; in 1747 he took a second wife, Mary Daniel, who had been his first wife's servant. Fielding abandoned playwriting, chiefly because of an Act of Parliament requiring that all plays be licensed, and returned to the law, being admitted to the bar in 1740. His professional returns were slight and undependable, and to supplement them he brought out a magazine on the *SPECTATOR* model, the *Champion*. In 1742 he published his first novel, *Joseph Andrews*, which he had begun as a parody on the languors and affectations of Richardson's *Pamela*. Encouraged by the success of this first venture, he issued *Miscellanies* in 1743, a 3-volume work containing the remarkable *Jonathan Wild the Great*. In 1749 his masterpiece, *TOM JONES*, appeared, and was followed in 1752 by *AMELIA*. His subsequent writings are not especially important, and indeed Fielding was never free from the necessity of doing literary hack work. The novelist died in Lisbon, Spain, Oct. 8, 1754, while undergoing one of his many "cures" for gout.

Fielding, along with SAMUEL RICHARDSON, is ranked as the father of the English novel. He was emphatically a man of his time. He stood six feet tall, and his massive body was matched by a huge appetite for pleasure of every kind. He was a well-known figure in the London taverns, and cudgel-playing and cock-fighting were among his favorite diversions. Significantly, one of his most congenial friends was the artist, WILLIAM HOGARTH. Above all Fielding was a man of actual experience who knew the world at first hand. Thackeray said of him that he was the last English writer who dared to draw a man. He could be completely generous in condoning the sins of a character like Tom Jones, but relentless in exposing the hypocrisy of the sneaking Blifil (see *TOM JONES*). His robust sense of humor carries him through even those frequent "asides" he wove into his novels, and which THACKERAY was later to emulate. He built almost flawless plots for his stories, and in this field set an example for all future novelists. His style was full-bodied without being heavy. His characterizations are best when he is portraying men and women of lusty, natural appetites, his rogues and his country squires being especially convincing. He has often been accused of coarseness and of failing to appreciate the more delicate sides of life. But, whatever his faults, Fielding stands, a gigantic and impressive

figure, at the very forefront of the great line of English novelists. See also ENGLISH LITERATURE.

BIBLIOGRAPHY.—Austin Dobson, *Fielding*, 1907; W. L. Cross, *The History of Henry Fielding*, 1918; F. T. Blanchard, *Fielding the Novelist*, 1926.

FIELD KITCHEN, equipment used in a military camp or along the route of march in preparing food for the troops. Field kitchens are of two types, rolling and stationary. The former consists essentially of a range mounted on wheels, and is used during movements. Stationary field kitchens are generally used in more or less permanent CAMPS. They ordinarily comprise ranges set up inside of special tents.

FIELD MUSEUM OF NATURAL HISTORY in Chicago, was founded in 1893 by the late Marshall Field. Mr. Field's original gift for this purpose was \$1,000,000, to which he added subsequent gifts totaling \$430,000 during his life. At his death he left the Museum a bequest of \$8,000,000, of which \$4,000,000 was assigned to the cost of a new building, and \$4,000,000 for endowment. Other notable gifts have been received from many civic leaders. The Museum now occupies a spacious and stately building, erected at a cost of more than \$7,000,000 and completed in 1921, in Grant Park near Lake Michigan. The collections it houses to-day have an estimated value of \$48,000,000.

The exhibits are grouped into four departments, Anthropology, Botany, Geology and Zoology. There are vast collections in each department, arranged systematically under their respective divisions and subdivisions. Of special interest are the larger exhibits including life-size groups representing aboriginal peoples of various lands engaged in typical occupations, a life-size restoration of a Neanderthal family, a restoration in natural size of part of a Coal Age forest, remarkable reproductions of plants and flowers, restorations of various prehistoric animals, the world's largest collection of meteorites, and the various series of habitat groups of animals showing them amid reproductions of scenes typical of their natural environments. High educational value is contributed by the carefully prepared labels displayed with all exhibits.

The Museum has been extraordinarily active in dispatching expeditions all over the world to collect material for its exhibits, and also for the large collections of study material maintained for scientists and students. A large staff of scientific men is employed, and much notable research has been conducted by them, the results of which are given forth in the Museum's internationally circulated publications.

The Museum possesses one of the most important natural history libraries in the country, containing more than 93,000 volumes, among which are many rare and valuable books long out of print.

Every effort is made to give the school children of Chicago the utmost benefit possible from the Museum. For this purpose there are two special units of the Museum organization. The department

of the N. W. Harris Public School Extension circulates more than 1,200 traveling exhibits of natural history and economic material to more than 430 schools and other institutions in the city, and through these approximately 500,000 children are reached many times a year. The James Nelson and Anna Louise Raymond Foundation for Public School and Children's Lectures provides lectures, motion pictures, and lantern slides for the entertainment and instruction of children, these being presented at gatherings both in the Museum itself and in classrooms and assembly halls of the schools. It conducts various other educational features, and its activities reach more than 250,000 children a year.

The Museum presents children's entertainments, and also lectures on science and travel for adults, in the James Simpson Theater, an auditorium in the Museum building, with seating capacity of more than 1,100 persons.

Latest attendance statistics of the Museum show close to a million and a half visitors coming to the institution in a year. E. I.

FIELD OF THE CLOTH OF GOLD, an historic name associated with the spot between Guines and Ardres in France which served as the meeting place between Henry VIII of England and Francis I of France in June 1520. The term was applied because of the unusually expensive and gorgeous background elaborately and sumptuously furnished to entertain the distinguished retinues of the two great monarchs. Although the meeting had little political consequence, the splendor and pomp of the display stirred the imagination of contemporary historians who have left us minute details of the event. Henry VIII departed for England on June 24, 1520.

FIELD PIECE, any gun serving in the field of military operations. Until the present century, the ordinary field piece was a light horse-drawn gun, not exceeding about 3" in caliber. A few guns of larger size, and small guns packed on mules for use in mountains, were occasionally utilized. Guns of 75 mm., 155 mm. and larger have now come into general use. Extremely large field pieces are towed by trucks or tractors, or moved and fired from railroad cars. In the World War, the largest guns ever built were employed as field pieces. See also ARTILLERY.

FIELDS, JAMES THOMAS (1817-81), American publisher and writer, was born at Portsmouth, N.H., Dec. 31, 1817. He became a partner in the publishing firm later known as Ticknor and Fields, and finally as Fields, Osgood and Company. From 1862-70 he edited *The Atlantic Monthly*, succeeding J. R. LOWELL. His excellent judgment and personal charm gave him wide influence in the literary world. Among his publications are *Yesterdays with Authors* and *Poems*. He died at Boston, Mass., Apr. 24, 1881.

FIELD SERVICE REGULATIONS, a term denoting a body of information, instructions and rules for the government of armies in the theater of operations. They deal with fundamental principles and methods applicable to the employment of combined

arms engaged in war service. Though designed especially for the government of the operations of large units, they apply also to small units constituting parts of a large command. Field service regulations supplement the regulations pertaining to each of the several branches of the military establishment by outlining or suggesting combination and coordination of the functions and tactics of the constituent branches of a major military force so as to develop its maximum efficiency as an organized unit. Principles and methods peculiar to individual branches are presented in training regulations for such branches. The field service regulations are designed to aid in developing the combination of effort, the teamwork, essential to military effectiveness. E. A. K.

FIELD SYSTEM. See OPEN FIELD SYSTEMS.

FIESOLE, an historic city of ancient Etruria, situated in northern Italy, 3 mi. northeast of Florence, at an altitude of 970 ft. The old acropolis was surrounded by a triple wall. Known as *Faesulae* it was one of the cities mentioned on Hannibal's route across the Apennines. Sulla settled some of his veterans here during the Catiline conspiracy; Manlius had his headquarters in the city. It fell to Belisarius in 539. The old Roman amphitheater, baths, and an Etruscan temple, afterwards the Roman Capitolium, are the chief remains. Pop. 1928, 10,003.

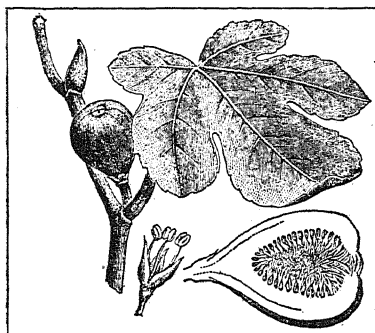
FIFE, a musical instrument of exceedingly shrill pitch used chiefly in military music and, in general, corresponding with the piccolo of the orchestra.

"FIFTY-FOUR FORTY OR FIGHT," a campaign slogan of the Democratic party in the presidential campaign of 1844, explained by its companion catch phrase, "All of Oregon or None." Oregon, a vast, undefined region between the Pacific Ocean and the Rocky Mountains from 42° to 54° 40' N. lat., was at the time open to occupation by citizens of Great Britain and of the United States. The increasing emigration to the region of American citizens prompted the demand, incorporated in the Democratic platform of 1844, that the United States assert exclusive title to the whole. The OREGON BOUNDARY TREATY, 1846, represented a compromise.

FIG (*Ficus carica*), a small tree of the mulberry family, native to the Mediterranean region, where, since remotely ancient times, it has been widely cultivated for its valuable fruit. The earliest Hebrew books mention the fig; Homer, Plato, and other Greek writers refer to it, and the Egyptian pyramids contain pictures of the fruit. It is a soft-wooded, much-branched tree, 10 to 30 feet high, with large, rough, deeply lobed leaves, bearing a pear-shaped, juicy fruit, in color ranging from red and yellow to green and blue-black. The pleasantly flavored fruit, delicious when eaten fresh, is extensively dried, canned, and preserved. Dried figs, long a staple article of commerce, are produced in large quantities in Asia Minor, especially in the Smyrna district.

Since about 1900 dried figs of the Smyrna quality have been produced in California, the commercial crop in 1929 exceeding 118,000,000 pounds. The fig

is cultivated also in the Gulf States, especially in Texas, where a fig-canning industry has been developed. See also *Ficus*.



COMMON FIG
Flowering branch, staminate flower and
section of a fig

FIG, INDIAN (*Opuntia Ficus-indica*), a bushy or sometimes treelike, usually spineless cactus, called also prickly pear. It is probably a native of tropical America and is now widely cultivated and naturalized in warm regions, especially in countries about the Mediterranean. The woody trunk grows from 10 to 15 ft. high with oblong, flattish joints, minute leaves which soon wither and drop off, yellow flower, 4 in. across, and a large, red, edible, berry-like fruit.

FIG INSECT, any species of hymenopterous insect of the sub-family *Agoninae*. A single species, *Blastophaga psenes*, occurs in the United States, introduced into California to make the production of Smyrna figs possible. This insect lives within the fig and fertilizes it. Fig flowers are borne inside the hollow receptacle which becomes the fruit. Eggs are laid on "gall-flowers" in wild figs. Adult females become covered with pollen from these flowers. They may enter the Smyrna fig to oviposit, fertilizing its flowers while so doing. Adult males are wingless. Common cultivated figs produce fruit without fertilization, but the Smyrna fig does not. J. R. T.

FIGS, SYRUP OF. See **CATHARTICS**.

FIGUEROA, FRANCISCO DE (c. 1536-c. 1620), Spanish poet, born at Alcalá de Henares, about 1536. He was a close friend of **CERVANTES**, who drew him in *Galatea* as "Tirsi." Figueroa was a soldier in Italy, where he also studied. When he was dying he commanded, like Vergil, that all his poems should be burned. Some few however were saved, and are superb poetic efforts.

FIGURES, in mathematics, any combination of geometric elements such as points, straight or curved lines, planes and surfaces. For example, squares, conic sections and prisms are geometric figures. The term is also applied to the numerals, 1, 2, 3, etc.

FIGURES OF SPEECH, intentional deviations from plain or ordinary modes of speech so as to present objects or ideas more accurately or more forcefully by viewing them in unusual lights or emphasizing them in unexpected ways. Scores of different

figures have been defined, but no completely satisfactory general method of classification has yet been attained.

The term trope (Latin *tropus*, "a turn") was used by Quintilian to denote a word or phrase "turned" from its literal meaning to a new signification, as when one calls factory-workers "hands," to give force to an idea. Contrasted to it are figures proper, wherein the mode of expression is varied, as when a simple statement is made into an explanation or a question, or a fact is stated ironically, in exaggerated terms, or in some other unusual way, to accentuate or emphasize the idea. Through inaccurate and indiscriminate use of the terms, however, this useful distinction between tropes and figures has not been preserved.

A convenient practical classification sufficient for most needs is to group figures under two headings. The first includes those which promote clearness and concreteness by comparing two similar or related objects of thought, including interpretation of one little-known in terms of another better known, or of an abstract in terms of a concrete, etc., this group consisting of synecdoche, metonymy, simile, metaphor, personification and allegory (see articles under these titles). The second class includes those figures which promote emphasis, accentuating a thought by expressing it in a peculiar and unusual form, such as apostrophe, hyperbole, irony, antithesis, epigram, climax and litotes. K. D. S.

BIBLIOGRAPHY.—A. Bain, *English Composition and Rhetoric*, 1872; C. M. Gayle and F. N. Scott, *An Introduction to the Methods and to the Materials of Literary Criticism*, 1899.

FIGWORT, the common name for the plants of a large genus (*Scrophularia*) of the figwort family. There are about 120 species, native chiefly to Mediterranean countries and central Asia; about six occur in North America. They are chiefly coarse perennials, often with an unpleasant odor, bearing opposite leaves and loose clusters of purplish or yellowish flowers. An European species (*S. nodosa*) was formerly used medicinally in treating scrofula.

FIJI ISLANDS, a group of about 250 islands in the Pacific Ocean lying east of the New Hebrides in 15° 50' N. lat. and 176° 40' E. long. They constitute a British colony with an area of 7,083 sq. mi. The largest of them are Viti Levu, which alone embraces half the area, and Vanua Levu. The rest are small, most of them mere islets. The soil of the Fijis is very productive and agriculture and live stock breeding are important industries. The chief crops are bananas, coconuts, tobacco, cotton, pineapples, sugar-cane, maize and rice. Horses, mules, cattle, sheep and goats are raised. The main industrial establishments are sugar refineries, dairies, cotton ginneries and rubber and rice mills. Suva, on the south coast of Viti Levu, is the capital. In 1928 the population of the Fijis was estimated at 176,793.

FILAMENT, a thread-like metal wire which, when heated by electrical energy, becomes incandescent (see **INCANDESCENT LAMP**), or, in the case of electronic

tubes (*see* TUBES, ELECTRONIC), gives off ELECTRONS. In 1879, EDISON sealed a filament of carbon in an evacuated glass bulb. When this was heated by an electric current, it served as an excellent source of light. The filaments in his lamps consisted of carbonized sewing thread, burnt bamboo fibers, or "squirted" CELLULOSE. Metal filaments were not used until 1898. Tantalum and fragile, pressed tungsten filaments were used until 1910, when they were superseded by the present drawn tungsten type developed by Coolidge. The modern filaments give from 8 LUMENS per watt in the smaller lamps to 30 in the larger; the early carbon type gave 1.4. Only approximately 6% of the total energy sent into the modern lamp is radiated as light.

The filaments used in radio tubes are designed to emit electrons rather than light; Richardson has shown that electrons actually evaporate from a hot filament. There are two types of filaments which are particularly efficient as sources of electrons: those made of thoriated tungsten with a surface layer of thorium, and those made of platinum coated with the oxides of barium and strontium.

FILAREE (*Erodium*), the name given to several small, annual, forage plants of the geranium family, native to Europe. The red-stemmed filaree (*E. cicutarium*), known also as alfalaria and pin-clover, is a much branched plant, with finely divided leaves, borne mostly in broad basal rosettes, and small pink



COURTESY IOWA GEOL. SURV.

FILAREE OR STORKSBILL
(*Erodium cicutarium*.) Single flower and
flowering stem (above). Single fruit
(below right)

flowers. It is extensively naturalized in the western United States, serving as winter pasture, and is sparingly grown for hay. The white-stemmed filaree or musk-clover (*E. moschatum*), extensively naturalized in California, and serving for forage, is occasionally planted in flower gardens.

FILARIA, the name of a genus of threadworms (*Nematoda*) which are parasites that live in the blood

or connective tissues of man and other animals. They are frequently carried from one host to another by blood-sucking insects, within whose bodies they may undergo part of their development. One of the most serious is the tropical and subtropical species (*Filaria sanguinis hominis*) which causes filariasis, sometimes accompanied by elephantiasis, in man. The young of this worm may enter the human body with contaminated drinking water, or they may be carried from one person to another by mosquitoes, which suck them up with the blood. Some develop to maturity within the mosquito's body. Then, when the insect is in the water, they escape, lay their eggs, and die.

FILBERT, a thick-shelled, sweet-flavored nut produced by the Old World hazel or filbert (*Corylus Avellana*) native to Europe, West Asia and North Africa, many varieties of which have long been cultivated. The filbert, known also as cobnut and hazelnut, and widely used for desserts and in confectionery, is a standard article of commerce. The seeds yield a bland fixed oil used by painters and perfumers.

FILDES, SIR LUKE (1844-1927), English genre and portrait painter, was born at Liverpool, Oct. 18, 1843. His painting, *The Doctor*, 1891, in the Tate Gallery, London, is one of the best known pictures in the world. Fildes also painted the coronation portraits of Edward VII and George V. He died at London, Feb. 27, 1927.

FILEFISH, a small marine fish (*Monacanthus hispidus*) of the filefish family (*Monacanthidae*), called also fool fish, common in Atlantic waters from Cape Cod to Brazil. It is about 6 in. long, dull green faintly mottled with white, with a short, deep, much compressed body, a very small mouth and a single large erect dorsal spine rising just back of the eyes. Its bitter flesh is valueless for food. Various allied species are also called filefish.

FILES AND RASPS, hand tools for making small alterations in metal, wood or other surfaces. They are long, slender pieces of steel, either flat, round, half-round, square or triangular in section. The faces carry small cutting edges or teeth that are formed on the smooth surface at an angle that will give a shearing action (*see* SHEAR) as the file is forced over the work. Files are made both single and double-cut, the second cut being at an opposite angle from the first, which leaves a series of sharp points rather than a single chisel-edge as with the single-cut file.

Files are also classified by the coarseness with which the teeth are cut, and they are designated by such terms as rough, bastard, second-cut, smooth, and dead-smooth or "floats." There are many special shapes of files for use on intricate forms. These are generally known as Swiss files. Nearly all files have a point or tang on one end which can be driven into a wooden handle.

The teeth of a *rasp* are not continuous across the surface as are those of a file, but are individual teeth, and alternate rows of the teeth are staggered forming an approximately uniform cutting surface. Rasps are

made with much coarser teeth than files and are used for wood and soft metals and for trimming horses' hoofs to fit shoes.

F. H. C.

FILIBUSTER, a word of Dutch origin used in three senses. 1. Originally, a *filibuster* was a pirate or freebooter. 2. In the 19th century the term came to be applied to one who, taking advantage of his association with a powerful group, organization or state, meddles with international law for purely private gain. Two outstanding examples are the Cuban expedition of Narcisso Lopez in 1850, and William Walker's various expeditions to Nicaragua, 1855-60. 3. One who clogs and retards political action by introducing side-issues.

FILIBUSTER, INTERNATIONAL, used at first to designate persons engaged in irregular and plundering military enterprises, but used more recently to indicate persons organizing movements against countries with which their country is at peace, and in violation of international law and of the municipal laws of the state regarding **NEUTRALITY**. Spain complained repeatedly of violations of American neutrality due to expeditions fitted out in American ports with a view to aiding the Spanish colonies in their efforts to gain independence.

C. E. MA.

FILIBUSTER, LEGISLATIVE, a technique of obstruction used by minorities in legislative assemblies to delay or prevent action on measures they oppose. Holding the floor on topics more or less irrelevant and necessitating frequent roll-calls, are the tactics commonly employed. The filibuster is most frequently resorted to in the United States Senate; in the House of Representatives, although filibustering can be terminated by the **CLOSURE** rules, it remains as a weapon against the power of the Speaker and the **MAJORITY**.

S. C. W.

BIBLIOGRAPHY.—C. A. Beard, *American Government and Politics*, 1924.

FILICAJA, VINCENZO DA (1642-1707), Italian poet, was born at Florence, Dec. 30, 1642. Educated at Pisa under Jesuit priests, he held important public posts; but his greatest title to fame rests upon his sonnets and odes. The repulse of the Turks from Vienna in 1683 inspired the *Canzoni*, a collection of odes that brought him wide acclaim. These together with his patriotic sonnets have earned him a reputation as the greatest Italian poet of the 17th century. Filicaja died at Florence, Sept. 24, 1707.

FILIGREE, a kind of jewelry resembling delicate lacework, formed by intertwining fine gold and silver wire. Little grains or beads of metal and precious stones are frequently set into the pattern of the wirework. The Egyptians made some filigree jewelry but the art was perfected by the Greeks in the 6th to the 3rd centuries B.C. The Spanish Moors in the Middle Ages were famous for their work in silver filigree.

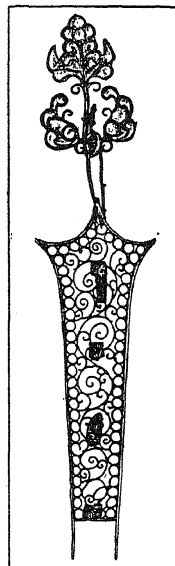
FILLAN, ST., Irish monk and missionary, was born in Ireland in the 8th century. At an early age he crossed to Scotland and became a monk. There he lived a long and strenuous life as a missionary.

The place where he is said to have died is called Strathfillan after him. Further facts concerning his life are obscured in legend. The saint's feast is celebrated on Jan. 9.

FILLION, P. J. (1868-), Canadian educator, was born at St. Laurent, Island of Orleans, near Quebec, Can., Feb. 9, 1868. He was graduated from Laval University, 1889 and 1900, and engaged in postgraduate work at the Institut Catholique and at the Sorbonne in Paris. After a distinguished service as professor of chemistry at Laval University he became rector of the university in June 1929.

FILLMORE, MILLARD (1800-74), 13th President of the United States, was born at Summer Hill, Cayuga Co., N.Y., July 7, 1800. His parents, Nathaniel and Phoebe Millard Fillmore, were of English descent. Their son grew up on the farm and until the age of 15 years was without the opportunities of a formal education. In 1819 he determined to become a lawyer. With four dollars in his pocket he set out for Buffalo, N.Y., where he obtained permission to study in a lawyer's office. By 1823 he had won the intercession of several attorneys in the Court of Common Pleas of Erie Co., which admitted him to the bar, although he had not studied the required length of time. He began practicing at Aurora, N.Y.

His rise in the legal profession was rapid and was accompanied by increasing political activity. In 1828 he was elected to the Legislature by the Anti-masonic Party. The following year he decided to move to Buffalo, where he formed a law partnership in 1830 with Nathan K. Hall and Solomon H. Haven. In the Legislature his opposition to imprisonment for debt won him popular support, and he determined to abandon law practice for a political career. Following the lead of Thurlow Weed, he became a firm Whig. In 1832 he was elected to the House of Representatives, where he served, except from 1835 to 1837, until 1842. In Congress he was a loyal supporter of Henry Clay, although he voted independently on occasion; for example, he opposed Clay's bill for the reestablishment of the National Bank. When away from Washington, he worked industriously to build up the Whig organization in his native state. His political organization contributed to the Whig landslide of 1840, and brought him the chairmanship of the important Ways and Means Committee in the House. In this advantageous position Fillmore helped write the tariff law of 1842, and was recognized as a representative of the industrial and financial interests of the North. In 1844 he was defeated by Silas Wright for the New York governorship, but in



COURTESY M. M. OF ART

GOLD FILIGREE OF
THE T'ANG DY-
NASTY, CHINA

1847 he was elected State Comptroller. In 1848 he won the Vice-Presidency, with Zachary Taylor as President. Fillmore's first four months in office were complicated by President Taylor's favors to Seward, and his own loyalty to the Clay faction in the party. On July 9, 1849, the President died, and Fillmore moved into the White House.

The Taylor cabinet promptly resigned. Among the new cabinet appointees were Daniel Webster, Secretary of State, Thomas Corwin, Secretary of the Treasury, and John J. Crittenden, Attorney-General. In the background Clay exerted a powerful influence on the President. With the aid of the Northern Democrats and the Southern Whigs, Fillmore and his party advisers settled the status of, and provided the state machinery for, California. He urged the payment of the Texas Claims for lands in New Mexico, and signed the Fugitive-Slave Bill, an act which made him unpopular with the Abolitionists. The death of Clay in 1852 was the signal for Whig reaction against both the President and Webster, and Fillmore began to lose support in the North, so that at the party convention of 1852, though he frankly bid for another term, he was not renominated.

Four years later, after the virtual dissolution of the Whig Party, he was nominated by the American (or Know-Nothing) Party, and ran a poor third in the election on an anti-secession platform. During the Civil War he was inactive, and spent his remaining years at Buffalo, where he died in 1874 of paralysis. Fillmore was twice married, in 1826 to Abigail Powers (d. 1853) of Moravia, N.Y., and in 1858 to Mrs. Carmichael McIntosh of Albany, N.Y. A son and a daughter were born by his first marriage. In religious affiliation Fillmore was a Unitarian.

BIBLIOGRAPHY.—M. E. Griffiths, *Millard Fillmore*; and "Millard Fillmore Papers," in *Buffalo Historical Society Publications*, Vols. 10 and 11, 1908.

FILMY FERN, the name given to a family (*Hymenophyllaceæ*) of small delicate ferns, often epiphytic on trees. They grow usually from hair-like creeping rootstocks, and bear much divided, almost transparent leaves (fronds), composed of a single layer of cells. There are two genera (*Trichomanes* and *Hymenophyllum*) and about 200 species, found chiefly in moist tropical regions, a few extending northward to western Europe and the southern United States.

FILTER, ELECTRICAL, an arrangement of INDUCTION COILS, CONDENSERS and CONDUCTORS whereby ALTERNATING CURRENT and direct current, if common in one part of a CIRCUIT, may be separated; also, an arrangement of similar apparatus either for passing or blocking alternating currents whose frequencies lie in specified regions.

FILTER, SEWAGE. See SEWAGE FILTERS.

FILTER, WATER. See FILTRATION.

FILTER-PASSING VIRUSES. In spite of extensive bacteriological investigations, a considerable group of infectious diseases cannot be proved to result from bacterial infection. In 1892 Iwanowski discov-

ered that mosaic disease of the tobacco plant was due to a virus that would pass through a porcelain filter; and in 1898 Loeffler and Frosch proved that foot and mouth disease of cattle was caused by a similar virus. This was the beginning of our knowledge of filter-passing viruses. Since that time, about fifty diseases have been placed in this group. The filterability of these pathogenic microorganisms is only relative. Some, such as the virus of foot and mouth disease, herpes and infectious sarcoma and leukemia of fowls, pass readily through compact filters. Others, such as the viruses of smallpox, poliomyelitis and rabies will pass only in limited amount through coarse meshed porcelain filters and then only when greatly diluted.

Most of the filter-passing viruses are too small to be visible by any possible magnification with the microscope, because their diameters are less than the wave-lengths of visible light. Some of them can be photographed by ultra-violet light, the wave-length of which is less than that of the visible spectrum. They can also be rendered visible as minute particles by dark ground illumination which is essentially an application of Tyndall's phenomenon. They will grow only in artificial culture media which contains a piece of living tissue and remain alive only so long as the tissue survives. Their presence in artificial cultures usually cannot be detected by ordinary bacteriological methods, but must be demonstrated by the production of the corresponding disease after injection of the fluid culture into a susceptible animal.

Different types of filterable viruses have specific affinities for certain organs of the body; as, for example, the virus of smallpox for the skin; those of rabies, encephalitis and poliomyelitis for the central nervous system. In the animal body, the viruses appear to live only within the cells. Some of the diseases of this group are characterized by "cell inclusions," such as the Negri bodies of rabies and the Guanieri bodies of smallpox. Since these structures are visible under high magnification, they can hardly be single microorganisms, but probably represent some stage in the life cycle of the virus.

The mosaic disease of plants, wilt of the gypsy moth caterpillar, sarcoma and leukemia of chickens, foot and mouth disease of cattle, distemper of dogs, rabies, smallpox, chicken-pox, herpes, encephalitis, poliomyelitis, warts, dengue fever, yellow fever and common colds, all of which appear to be due to a virus more or less able to pass through some form of porcelain filter capable of holding back ordinary bacteria,—present striking differences in clinical manifestations and underlying pathology. The virus diseases also vary in their modes of transmission. Smallpox is extremely contagious; poliomyelitis and chicken-pox are somewhat less readily acquired; rabies is transmitted by the bite of rabid animals, and dengue and yellow fever by mosquitoes. An animal that has recovered from a virus disease is usually permanently immune to that disease.

J. P. S.

FILTERS, LIGHT, certain liquids, solids or gases which have the property of altering the COLOR or

intensity of LIGHT which passes through them. Gas filters are rarely used. The most common use of filters is in PHOTOGRAPHY, but they are also used extensively in SPECTROSCOPY, PHOTOMETRY, MICROSCOPY.

Most light filters consist of GELATINE films containing dyes, these films usually being cemented between glass plates with CANADA BALSAM. Another form often used is an all-glass filter, wherein the glass itself contains the proper light-absorbing substances. These colored glasses are usually more stable than the dyed gelatine filters, some of which deteriorate under the action of light. As the variety of glass filters thus far produced is rather small, the gelatine filters predominate. The transmission or absorption characteristics (*see* ABSORPTION OF LIGHT) of any filter cannot be determined by mere visual inspection of its color. In scientific work, these characteristics are usually obtained by analysis with a SPECTROPHOTOMETER.

There are three general classes of filters: selective filters, which transmit only a narrow range of WAVELENGTHS; subtractive filters, which absorb only a narrow range; and compensating filters, whose transmission varies over a wide range in a way suited to some special needs.

In order that a photograph of a colored object (*see* COLOR PHOTOGRAPHY) may reproduce the brightness of the various colors as they appear visually, it is necessary to use a yellow "orthochromatic" filter. This type contains a dye whose spectral transmission compensates partially, at least, for the selective sensitivity both of the photographic emulsion to blue light and of the human eye to yellow and green light.

To distinguish between two objects which differ from one another in color but not in tone, it is necessary to use a contrast filter, which modifies the brightness of some particular color. Thus, to make a given color appear as dark as possible, it is photographed through a filter which absorbs that color; in order to render detail, a filter of the same color as the object is used.

In photographing colored objects for reproduction in color, three selective filters of red, green and blue are usually employed, so adjusted that their regions of transmission just overlap. In processes of photography in natural colors by such processes as the Autochrome, Agfa and Finlay, a special compensating filter is used.

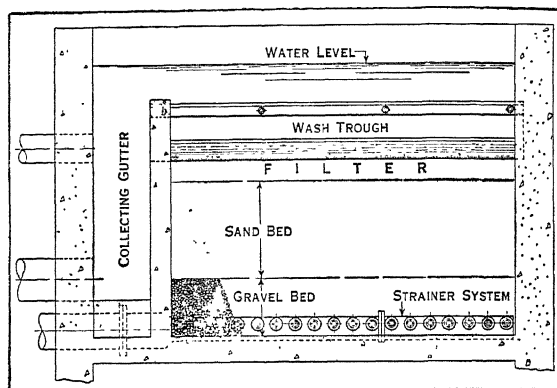
In photomicrography, contrast filters are used when photographing stained sections and other objects exhibiting strong colors. They are also used to advantage for visual work with the MICROSCOPE.

In photometry, filters are sometimes used to compare two sources which differ markedly in color. Yellow filters reduce the color of light from high-efficiency lamps to a color corresponding to that of low-efficiency lamps; blue filters accomplish the reverse process. The transmission of the filter must be known, in either case.

In SPECTROSCOPY, filters are often used to isolate some portion of the spectrum and to eliminate scattered light.

T. S.

FILTRATION, the operation of separating fine solid particles from a liquid or gas in which they are suspended. The operation is carried out on a large scale in many chemical and metallurgical industries.



COURTESY E. W. BACHARACH & CO.

LONGITUDINAL SECTION THROUGH SAND FILTER

The essential feature of a filter is the filtering medium, which is a layer of material or a porous membrane that allows the fluid to pass, but retains the solid particles in the form of a filter cake. The filter media most often used are: sand beds, sheets of paper or cloth, and fine-mesh metal screen cloth. The medium is mounted in a container, the mixture to be filtered is forced against one side of the medium, the liquid passes through the medium, and the solids are caught. In most modern filters, the cake can be washed with fresh liquid before being removed from the filter.

Filtration of public water supplies is desirable when water free from objectionable odor, taste, color, turbidity and dangerous bacteria cannot be obtained from natural sources by storage or by sedimentation. It consists in passing the water through sand-beds usually 24 to 30 inches thick, upon and in the upper portions of which are natural "mats" of suspended colloidal matter through which the water will percolate but which will retain all suspended solids, as well as 90 to 95% of the bacteria. The *rapid sand filter* predominates over the *slow sand filter* in the U.S. because of its greater capacity per square foot, lower first cost and its ability to handle a greater variety of water. A chemical coagulant is used to give an efficient "mat" quickly, while with the slow sand type the water must be applied slowly at first, gradually increasing the quantity. Three days may elapse before the full rated capacity is reached. A rapid sand filter operating at a rate of two gallons per square foot per minute will successfully clarify a properly coagulated water having a turbidity of 35 to 40 parts per million, or 20 to 40 times the rate of the slow sand filter. *See also* WATER TREATMENT.

FINANCE, in general, money payments and monetary transactions. Funds in money, for any purpose, are spoken of as finances.

There are three fields in each of which the term is applied with different connotations. The three fields overlap, as is natural because the same idea, money

payment, runs throughout. Thus we speak of the financial system of a country, meaning thereby the legal money, in coin or paper, the banking policy, and related matters. The history of money and banking in the United States is exceedingly interesting, covering as it does, among other things, the struggles of the colonies to obtain, after various disastrous experiments with unsound schemes, a safe system of money and banking; the establishment of our Federal gold and silver coinage; wild-cat banking in the forties; the greenbacks of the Civil War; the national banks and the FEDERAL RESERVE SYSTEM.

Again one speaks of business corporation or investment finance. This covers all the ways and means of providing capital for incorporated and other enterprises. It deals with shares of capital STOCK, BONDS of various sorts, the stock market, the mathematical methods of computing the return on bonds and other securities, CRISES, PANICS and the BUSINESS CYCLE with its alternating periods of prosperity and depression. High finance, or the manipulation of the finances of corporations with a view to making the promoters unduly rich, falls in this field.

Finally there is the science of public finance or government finance, which deals with the ways in which governments raise and spend the funds they need. It is often spoken of as a branch of economics, but it is also closely related to political science, and almost as intimately with law or jurisprudence, for the courts are continuously dealing with questions in this field. Taxation is the center of public finance, but it also inquires into the purposes for which the funds raised by taxation are spent, their necessity, wisdom and how beneficial the spending is to the people. Of taxes there are many kinds. In the United States there are: CUSTOMS DUTIES levied on goods imported, a number of excise taxes levied on goods made or sold in the country, a Federal income tax, and in some of the states another one, a Federal estate tax, and, in nearly all the states, inheritance taxes; in the several states are almost everywhere a general property tax, used not only for the support of state government, but, also, for the counties (*see* COUNTY), municipalities (*see* MUNICIPAL GOVERNMENT) and numerous districts of which the school districts are the most important.

Public finance also deals with public debts which have grown to huge sums in the last century and a half, largely as a result of wars, but, also, to promote the public welfare more rapidly than could be done by taxation only. The development of schools and the building of good roads have been advanced by public borrowing.

C. C. P.

FINANCE BILL, a term applied to a Bill of Exchange which is drawn, not to finance a specific sale of goods, but to obtain funds for some other purpose, legitimate or speculative. Such bills are not accompanied by warehouse receipts, bills of lading, insurance or other documents that mark the trade bill. Because they are not associated with a specific transaction, the funds to liquidate them are not provided

by the consummation of the transaction involved, which provides the security of a trade bill. *See* FOREIGN EXCHANGE.

FINANCE DEPARTMENT, ARMY, U.S. The Finance Department is the agency through which the War Department pays its personnel and bills, makes collections and audits the property accounts in the hands of accountable officers. The property accounting records of the nonmilitary or civil activities of the War Department are not audited by the Finance Department.

This branch consists of a Chief of Finance with the rank of major general, 128 officers in grades from colonel to first lieutenant and 380 enlisted men.

At each corps area headquarters there is a finance officer known as the corps area finance officer. His jurisdiction is coextensive with that of his commanding officer. The Finance Department maintains in Washington, D.C., a finance school which graduates on an average more than 60 students a year.

S. C. V.

FINANCE PAPER. Manufacturers and distributors of certain commodities found that they could enlarge their volume of sales and thereby reduce the percentage of production expenses and increase profits with safety, by arranging the retail selling of their product on the installment plan, taking in return installment notes or partial payment contracts secured by liens on the articles.

Manufacturers of pianos were, perhaps the first to use the system, a generation ago, but now automobiles, radios, washing-machines, electric refrigerators, bathrooms and even garages may be purchased on this basis.

The early plan accomplished increased sales but manufacturers and distributors found that funds and CREDIT, tied up in these receivables, absorbed large amounts of capital and a method of carrying them was needed. The history or experience record of collecting this form of obligation proved to be distinctly high and as a result corporations were formed to finance such time payments and were generally classed as finance companies. These so-called finance companies purchased the consumers' contracts or notes, sometimes with and sometimes without the guaranty of the manufacturer or distributor. Notes so guaranteed were called recourse paper. The early finance companies, being carefully organized, were very successful and in time they multiplied in numbers to such an extent that they developed an intense competition among themselves for sound business. The competition among the finance companies has practically eliminated the necessity of the manufacturer guaranteeing the payment of the paper. With their capital fund the finance companies established bank lines and credit with commercial banks thus increasing the volume they could handle. They discounted with the banks, in some cases their own unsecured notes, but in most cases their own notes secured by the consumers' obligations, safeguarded by liens, with a margin of from 10 to 50%, trusted as collateral

with a bank or trust company and so certified to on their own note. Some finance companies gave the banks an additional safeguard in the form of a surety company's guaranty of their note.

The return on these notes is higher than on normal COMMERCIAL PAPER as they differ from such normal commercial paper in that they are not at present eligible for rediscount at the FEDERAL RESERVE BANK. However, proving an attractive risk for banks seeking investments, this class of paper was found to be readily marketed through brokers under the general title of Finance Paper.

The depression beginning in 1929 constituted a severe test as to the inherent soundness of the finance company idea and the final outcome has been watched with interest. However, the normal liquidation of these purchase obligations continued to a remarkable degree, when the amount of unemployment and the extent to which partial payments are dependent upon continued employment are considered. The percentage of forced recapture, i.e., where the finance company has had to take over the article sold because of non-payment of the purchaser's note, is very small. It is therefore fair to presume that with almost 20 years of successful development finance paper as a means of increasing sales has come to stay and has proved to be sound in practice and principle, when the fundamental principles that have been worked out by leading companies in this line are adhered to. It must be recognized, however, that a violation of these sound principles may involve undue risks.

H. C. SM.

FINCHES, a name commonly applied to a numerous family (*Fringillidae*) of sparrow-like birds. They constitute the largest of all bird families and include the sparrows, grosbeaks, goldfinches, linnets, buntings and many other seed-eating birds. By some authorities they are regarded as representing the highest development attained by birds. There are fully 1,200 species and subspecies, found throughout the world except in the Australian region. About 200 of these occur in the United States and Canada. Although they exhibit a wide diversity of form and habits, the majority of the species are gregarious and arboreal, only a few living extensively upon the ground. They are birds of small or moderate size, with rather stout bodies and usually plain plumage, though some are among the most brilliantly colored of native North American birds. Their bills are usually stout and conical, adapted to crushing seeds, but are sometimes more slender and sharply pointed or even crossed, as in the crossbills. Finches subsist largely upon weed seeds, rendering great service to agriculture, but they also feed to some extent upon insects and berries. Many rank among the finest of song birds, and some, as the canary, are favorite cage birds. See also BULLFINCH; BUNTING; CANARY; CARDINAL; CHAFFINCH; CROSSBILL; GOLDFINCH; GREENFINCH; GROSBEEK; HAWFINCH; LINNET; SPARROW.

FINCK, HENRY THEOPHILUS (1854-1926), American writer, was born at Bethel, Mo., Sept. 22,

1854. He graduated from Harvard, and studied psychology abroad for three years. Then an appointment from the New York *World* to write up the first Bayreuth festival changed his career. From that time until two years before his death, 1881-1924, he was musical critic for the New York *Evening Post*. Finck wrote on various subjects, but his chief aim was to increase the public appreciation of Wagner, Grieg, Chopin and other composers. Among his books are *Edward Grieg, Wagner and his Works*, and *Primitive Love and Love Stories*. He died at Rumford Falls, Me., Oct. 1, 1926.

FINDLAY, a city of northwestern Ohio, and county seat of Hancock Co., divided by the Blanchard River, 45 mi. south of Toledo. Several big railroad lines intersect at Findlay and it has a commercial airport. There is a supply of natural gas, and some of the more important industries depend largely on the petroleum resources of the Lima oil field, and limestone deposits. The manufacture of rubber tires is a prominent industry. In 1929 manufactures had an approximate value of \$16,000,000; the retail trade reached a total of \$12,313,456. Findlay College is the chief educational institution. The Wyandot Indian Caverns and the Underground River Cave near Findlay are of interest. The original settlement, which grew up around Ft. Findlay, established during the War of 1812, was plotted in 1821 and incorporated in 1837. In 1886 the discovery of oil and gas caused a spectacular rise in population. The boom quickly subsided and the ensuing slump lasted until 1910, when a normal development set in. Pop. 1920, 17,021; 1930, 19,363.

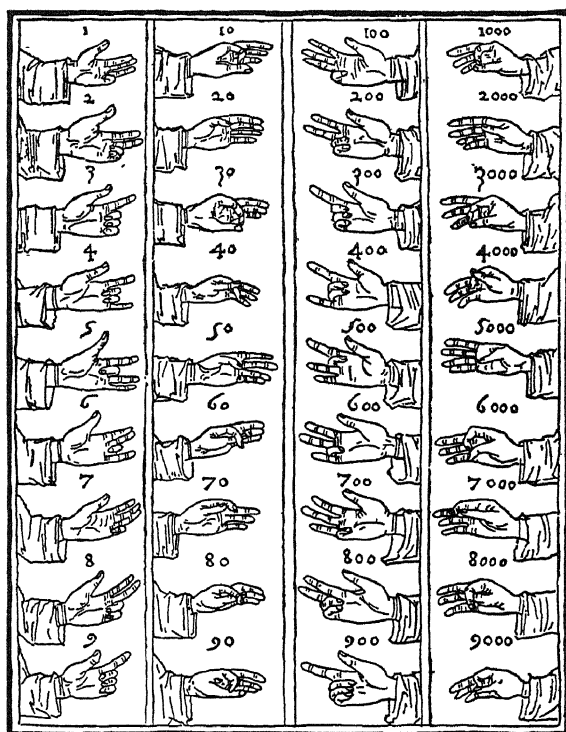
FINE ARTS. See articles under ARCHITECTURE; ARTS AND CRAFTS; MUSIC; WATER COLOR PAINTING; PORTRAIT PAINTING; SCULPTURE.

FINGAL'S CAVE, the most famous of a series of remarkably beautiful sea-caverns on the volcanic island of Staffa, off the west coast of Scotland. Quarried by the waves from the jointed columnar basalt of an ancient lava-flow, this spectacular grotto runs inland 220 ft. It is entered through a pillared arch 65 ft. high. The floor of the interior are the waves of the sea. Small boats occasionally enter the cave, but visitors, arriving by tourist steamers from Oban, ordinarily land near Clam Shell Cave, whence a flight of steps leads to the mouth of the grotto.

FINGER LAKES, a group of beautiful lakes located in west central New York. These lakes which are long, narrow and finger-like, lie practically parallel to each other in a general north-south direction. They were formed during the glacial age by the blocking of deep river valleys with glacial residue. The region is characterized by falls and glens, many of which have been purchased by the state of New York. Chief among these state parks is Watkins Glen near the head of Seneca Lake and about 20 mi. north of Elmira. Through this narrow ravine, which in places is 700 ft. deep, runs a small stream forming delightful waterfalls, cascades and rapids. Enfield Glen, also a state park, is 7 mi. south of Ithaca.

This glen has 12 waterfalls, of which Lucifer Falls, the highest, has a 115 ft. drop. Seneca and Cayuga, each about 40 mi. long and from 2 to 3 mi. wide, are the largest of the Finger Lakes. Other lakes in the group are Canandaigua, Skaneateles, Owasco and Otisco.

FINGER NUMERALS. The expression of numbers by means of the fingers is doubtless prehistoric and is certainly one of the oldest methods known. From this primitive scheme there developed in ancient times an elaborate system of finger numerals. The smaller numbers of daily life seem to have been indicated on the left hand, being pointed to by the index finger of the right. The hundreds were indi-



PACIOLI'S SYSTEM OF FINGER NUMERALS
From the *Sūma* of Pacioli, Venice, 1494

cated on the right hand. The Latin poet Juvenal speaks of a man over 100 years of age as one who counts his years upon his right hand, *suos iam dextra computat annos*. The system was common until relatively modern times and, indeed, has not wholly disappeared even yet. Some idea of the nature of the symbols may be had by examining the reproduced page from Pacioli's *Sūma*, printed in Venice in 1494. It is, in its essential purpose, not unlike the systems used by the deaf and dumb, and was a kind of international method of communicating number ideas.

See NUMERALS; FINGER RECKONING.

FINGER PRINTS. The palmar and plantar surfaces of the hand and foot are covered with a characteristic relief composed of patterns of fine lines or ridges. These ridges are found nowhere else on the integumental covering of the organism and corre-

spond to underlying papillae. The width of such a cutaneous ridge in man is usually about .2 mm. The patterns produced by these ridges become increasingly complex in an evolutionary series from lemurs to man. The tips of the fingers present the most complicated designs.

The present-day interest in finger prints was stimulated by the work of Sir Francis Galton who pointed out the permanence of the pattern in the life of the individual and that no two individuals have identical patterns in all respects. Galton suggested a method of classification that is still in use, but many now follow the system devised by Bonnevieu. Finger print patterns are usually classified, according to the configuration of the cutaneous ridges, as arches, loops and whorls and are further differentiated by composites and direction. Newman and others have shown that types of patterns may be inherited.

The permanence of the finger print has led criminologists to use them in the identification of criminals. The usual method of taking an impression of the finger tips is to ink the fingers by pressing on an inked glass surface after which the fingers are pressed upon a sheet of paper.

H. L. S.

Fingerprinting constitutes a valuable key to previous court records and case histories from institutions and social agencies. In California a state law consolidates all criminal identification and fingerprinting immediately following arrest is obligatory in all cases except minor infractions. In some states fingerprinting is allowed only after conviction and in others only after sentence. Fingerprinting before determining bail is especially valuable and New York has a law making it compulsory. In the present use of probation accurate fingerprint identification is important, as recidivists should be kept from probation.

For effectiveness there must be close cooperation between the various law enforcement agencies. To this end Criminal Identification Bureaus have been set up in Washington and in various States. Cooperation being a matter of choice, it frequently happens that local authorities fail to register fingerprints with the central bureaus unless local identification has proved negative and outside assistance is required.

G. W.

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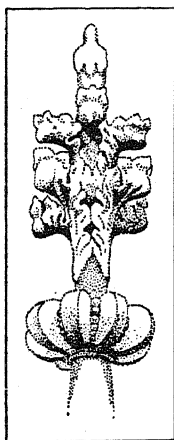
FINGER RECKONING is a general term applied to various methods of computing by the aid of the fingers. From the use of FINGER NUMERALS there arose, probably in medieval times but possibly in the ancient civilizations, a scheme of computation by the same means. For example, to find 6×9 , raise one finger on one hand (because $10 - 9 = 1$) and four fingers on the other hand (because $10 - 6 = 4$). Then multiply the standing fingers, 1×4 , for the units and add the closed fingers, $4 + 1$, for the tens, the result being 54. In the case of 7×8 we would have $3 \times 2 = 6$, the units, and $2 + 3 = 5$, the tens. This depends on the fact that $ab = 10[5 - (10 - a) + 5 - (10 - b)] + (10 - a)(10 - b)$. In the case

of a and b lying between 5 and 10, this requires learning the multiplication table only to 5's. A similar device was used for other numbers. For example, to find 14×13 , raise four fingers on one hand and three on the other. Then to 100 add ten times the sum of the raised fingers, and the product of the same numbers, the result being $100 + 10(4 + 3) + 4 \times 3 = 182$. This depends upon the identity

$$ab = 100 + 10(a - 10 + b - 10) + (a - 10)(b - 10).$$

D. E. S.

FINIAL, the knobby ornament which, in Gothic architecture, finishes the top of a pinnacle gable or spire. It is usually cut in a conventionalized foliage design, often recalling in spirit and outline the character of the **CROCKETS** which decorate the edges of the gable or spire it crowns.



FINIAL FROM REIMS
CATHEDRAL

FINISHING TEXTILES. See TEXTILE FINISHING.

FINLAND, in Finnish Suomi, a republic of northern Europe, established in 1917. With an area of 149,981 sq. mi., in 1930 it had a population of 3,658,125, or 24.4 persons per sq. mi. On the north is Norwegian Lapland and the Arctic Ocean, on the east is Russia, on the south the Gulf of Finland and on the west the Gulf of Bothnia and Sweden. The following are the nine provinces of the country: Uusimaa, Turku-Pori, Ahvenanmaa, Hame, Viipuri, Mikkeli, Kuopio, Vaasa and Oulu. **HELSINKI** (Helsingfors), the capital, had a population of 241,115 in 1930. Other important cities are **TURKU**, with a population of 66,234; **TAMPERE**, 55,514; **VIIPURI**, 56,295; **VAASA**, 25,591; **Oulu**, 24,166; **Kuopio**, 24,341; **Pori**, 18,395; **Kotka**, 17,436. In 1920, 2,754,228 were classified as Finns, 340,963 as Swedes, 4,806 as Russians, 2,378 as Germans and 1,603 as Lapps. 65% of the population were engaged in agriculture, 15% in industry, 3% in communications, 3% in commerce, 2% in public administration and 10% in other pursuits.

Surface Features. Finland is sometimes known as the land of a thousand lakes. Geographically it consists of a tableland rising between 400 and 600 ft. above sea level. Of this expanse 73.4% is covered by forests, 11.5% by lakes, 8.8% by grassland and other uncultivated land, while but 6.3% is cultivated soil. Among the scenic features of the country are Lake **LADOGA** and the **Imatra Rapids** and numerous mighty rivers.

Agriculture and Manufactures. Agriculture is the leading occupation, although only 6.3% of the land area is devoted to it. In 1928 the country produced 279,379 tons of rye, 125,534 tons of barley, 569,782 tons of oats, 668,905 tons of potatoes and 24,225 tons of butter. In 1929 there were 4,109 fac-

tories employing 165,073 workers. Their total product was valued at 13,500 million marks. This was distributed as follows: iron and mechanical works, 1,694,133,400 marks; textiles, 1,201,696,200; wood industry, 3,155,980,800; paper, 2,513,940,700; leather, rubber and fur, 616,448,200; chemicals, 341,731,600; graphic arts, 295,385,600; tobacco, 353,961,200; electricity, gas and water, 479,687,600. The imports in 1930 amounted to 5,247,671 thousands of marks; the exports came to 5,404,158 thousands of marks. Chief among the imports are cereals, colonial produce and spices, spinning material, textiles, leather, hides, furs, metals, machinery, minerals and earths; the main exports are live animals, food from animals, timber, pulp, paper and leather products, hides, furs, minerals and earths, gums, resins and tar, matches and explosives.

Religion and Education. Although freedom of worship is granted, the Evangelical Lutheran Church is the national church of Finland. In 1929 there were 3,514,036 Lutherans, 61,653 Greek Catholics, 714 Catholics and 46,125 Baptists, Congregationalists and others. There are three universities: that at Helsinki, founded in 1640 at Turku but removed to the capital city in 1827, with an enrolment of 5,126 students; and the Swedish and the Finnish universities, both at Turku, and founded since the war. Besides these there are two commercial (Finnish and Swedish) and one technical institute at Helsinki. In 1929 the country had 125 lyceums, 80 middle schools, 56 high schools, 4,963 elementary schools and 867 infant schools, the latter being under the church. There were eight colleges for the training of elementary school teachers and four for infant school teachers. Among the other schools were 5 for navigation, 43 for commerce, 10 industrial, 50 agricultural, 4 dairy, 43 cattle management, 42 household, 8 horticultural and 5 forestry schools. Among persons over 15 years of age only 1% are illiterate.

Government. The legislative branch of the government consists of only one chamber, a house of representatives of 200 members. These are elected by universal suffrage on the basis of proportional representation, 24 years being the voting age. The president is indirectly elected for six years by the citizens through 300 electors. The cabinet, called the council of state, is appointed by the president and must have the vote of confidence of the house of representatives. The judiciary is independent of the government. Three types of courts are provided for, the district, the courts of appeals and the supreme court. In legal procedure the judge decides the case unless the verdict of 12 jurors is unanimously against him. He may be removed by sentence.

Transportation and Banking. In 1930 there were about 20,000 mi. of roads and 3,332 mi. of railroads, all but 165 mi. of which are owned by the state. The lakes and canals form a waterway of 2,500 mi. connecting with the gulfs of Finland and Bothnia. The monetary unit is the mark. The Bank of Finland, founded in 1811, is the only bank

allowed to issue currency. The estimated revenue for 1931 in thousands of marks was 4,400,000; expenditures, 4,412,300.

HISTORY

Of the early history of Finland and the Finns, little is known beyond the fact that the country has been settled for several thousands of years. The so-called Swedish conquest, which began about the middle of the 12th century and was completed by the close of the 13th, made Finland a part of Sweden. At the time of the conquest, Sweden was not yet a unified state. Later, when unification was achieved, Finland became an integral part of the Swedish kingdom. The union lasted till 1808-09, when it was brought to a close as an incidental consequence of the Napoleonic Wars. Throughout the Swedish period, the inhabitants of both sections of the kingdom were equally "native Swedes" before the law, in the matter of appointments, representation in the Riksdag and the like. When Finland was ceded to Russia in 1809, her law and administration of justice, Governmental organization and religious and educational life were institutionalized according to patterns that had been evolved in Sweden-Finland in preceding centuries.

Finland became a part of Russia as an autonomous, constitutional Grand Duchy. The Government under which this status was assumed was established in 1809 and the following years. The fundamental law and institutions of the Swedish period were maintained with only minor changes necessitated by the victory of Russia. An appointive Government Council, modeled on the Swedish Council of State, was created, and provision made for a legislative Diet. Putting it broadly, this autonomy meant the following: the right of Finnish citizens to enjoy the full benefits of the country's laws, legal institutions and practices was expressly recognized; excepting the Governor General, only Finnish citizens could be appointed to public office; acting through the Diet, the people could decide concerning the changing of old and the making of new laws. Foreign relations, however, were under Russian control. Also, the Diet could be convoked only at the instance of the Grand Duke. His consent was required for all legislation; but his own power was limited in several important ways. For example, the Constitution could be changed only with the Diet's consent and tax measures required its cooperation.

While the autonomy of the country remained unchanged and unchallenged till the close of the last century, political progress began only in 1863, when the Diet was convoked for the first time since 1809. Five-year Diets were established in 1869; after 1882 the legislature met at least every third year. A Finnish, national coinage was obtained in 1865; a national system of public education was established in 1866; and during the closing decades of the century, a growing body of social legislation testified to manifold ways in which the Industrial Revolution, which began after 1860, was transforming the economic, social and intellectual development of the country.

With the rise of Pan Slavism in Russia, Finland's constitution and privileged position became objects of attack. An Imperial Manifesto was issued in Feb. 1899, whereby all Finnish legislation was placed under the surveillance of Russian authorities, and during the following years Russification was energetically continued. The Russian Revolution of 1905 gave a few years' respite. A new Parliament Act was passed in 1906. It changed the Diet of four Estates into a thoroughly democratic unicameral Parliament of 200, chosen by universal and equal suffrage; women were placed on a footing of complete equality with men.

Russification gained ground rapidly after 1908, and by 1914 amalgamation with Russia threatened. The Russian Revolution of 1917 paved the way for a declaration of independence on Dec. 6, 1917. The independence then proclaimed had been prepared during the war by secret patriot endeavor, but it was rendered secure only after a short war in 1918, in which the Finns, aided by German troops, put down the Red and Russian forces opposed to the legal Government. The collapse of Germany in 1918 enabled Finland to escape the position of a German dependency, and the Republic was established by the Constitution of July 1919. In Oct. 1920, peace was concluded with Russia. Dr. Kaarlo Stahlberg, Progressive, was chosen President in the same year. He was succeeded by L. Relander, Agrarian, in 1925, and P. E. Svinhufvud, Conservative Coalition, became President in 1931.

The agrarian law (*Lex Kallio*) of 1921 and the Prohibition Law which went into effect in 1919 stand out among the important legislative measures since 1919. The latter was repudiated by a national referendum in Dec. 1931.

J. H. WU.

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FINLAYSON, JOHN DUNCAN (1886-), American educator, was born at Thessalon, Ont., Can., May 16, 1886. He was graduated from the University of Michigan, 1911; studied theology, and was ordained to the Presbyterian ministry in 1914. After preaching several years, he took up educational work. During his presidency of Fairmount College, Wichita, Kan., 1922-26, he reorganized it into the municipal University of Wichita, over which he presided, 1926-27. He became chancellor of the University of Tulsa in 1927.

FINLEY, JOHN HUSTON (1863-), American educator and editor, was born at Grand Ridge, Ill., Oct. 19, 1863. He graduated from Knox College in 1887 and did graduate work at Johns Hopkins the following two years. In 1892 he was made president of Knox College, serving until 1899 when he became editor of *Harper's Weekly*. The following year he was editor of *McClure's Magazine*. From 1900-03 he was professor of politics at Princeton, and from 1903-

1913 president of the College of the City of New York. This led to his appointment, 1913, as a commissioner of education and later as president of the University of the State of New York, which office he held until 1921. He then joined the *New York Times* as an editorial writer. Finley has devoted much time to philanthropic and civic causes. He was a member of the board of arbitration in the eastern railway controversy 1913-14 and head of the American Red Cross in Palestine and the Near East 1918-19.

Among his writings are *Taxation in American States and Cities* (with Richard Ely), 1889; *The American Executive and Executive Methods* (with John Sanderson), 1908; and *The Debt Eternal*, 1923.

FINN, MAC CUMHAILL (c. 250), hero of a vast collection of Gaelic folklore of Ireland, Scotland and the Isle of Man. Finn was probably the general who organized an army for Cormac mac Airt, king in Tara, when that king was endeavoring to bring the whole of Ireland under his rule. In the tales Finn is the leader of a group of warriors who, when not busy defending Ireland against various foreign invaders, enjoy following the chase. The tales are rich in humor and the characters are well and consistently drawn.

FINNISH, a language of the western branch of the FINNO-UGRIC linguistic family, its nearest relatives being ESTONIAN, Karelian, Livonian, Vepse and Votian. Finnish consonantism is characterized by consonant alternation, of which there are two types, *kk* or *k* and *p* or *v*, the strong or long grade appearing in an open, and the weak or short in a closed syllable; and the vocalism is characterized by a large number of diphthongs and VOWEL-HARMONY. Syntactic relations are expressed by inflectional endings; and though there is only one declension and one conjugation, there are a number of inflectional types, due to internal changes in the consonantism of the stem. Most of the Finnish case-endings have been developed since the separation of the Finnic branch from the Ugric. The verbal inflection is poor in tenses, but very rich in derivative forms expressing aspects (*see* ASPECT).

Finnish has borrowed extensively from the vocabularies of Balto-Slavic and Germanic (*see* BALTIC; SLAVIC; GERMANIC), beginning from their earliest periods, and thus contains valuable material for explaining certain Balto-Slavic and Germanic phonological problems. B. J. O.

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FINNO-UGRIC, a family of languages (*see* FAMILY, LINGUISTIC) composed of two principal branches, Finnic and Ugric, the most important members of the former being FINNISH and ESTONIAN, and of the latter HUNGARIAN or Magyar. The family is related to the Samoyed languages, with which it constitutes a larger group called Uralian.

Primitive Finno-Ugric had, and still retains, only a single initial consonant. Medial consonants were subject to an alternation of a strong and a weak grade, the former appearing after an accented, and the latter after an unaccented vowel. This alternation was both quantitative and qualitative, so that there were two series of grades of the type *kk-k*, *p-v*, etc. Finnish has preserved this original condition rather well, but many of the cognate languages have leveled it in favor of the weak grade. A characteristic of the vocalism is vocalic harmony, although this is not an original Finno-Ugric phenomenon, but a later development, nor is it strictly carried out in any of the languages of this group, being best developed in Hungarian and Finnish. The accent alternated in the parent Finno-Ugric between the first and second syllable, this evidently being a cause of the gradation of consonants; and in connection with this alternation there was apparently a sort of vocalic alternation (*see* ALTERNATION, VOCALIC). Syntactic relations were expressed by suffixes, which developed in many instances into regular endings. The endings in singular, dual and plural were the same.

All Finno-Ugric languages contain words borrowed from INDO-EUROPEAN at different periods, so that they offer, for instance, valuable material for a study of the earliest historical stages of GERMANIC. B. J. O.

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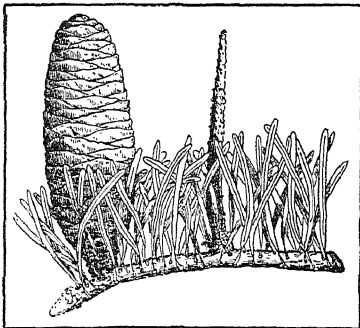
FINSEN, NIELS RYBERG (1860-1904), Danish physician, born on December 15, 1860, at Thorshavn, in the Faroe Islands, received his M.D. degree from the University of Copenhagen in 1890. He conducted extensive experiments on the physiologic effect of light. He developed the red light treatment to prevent pitting in smallpox by the exclusion of ultra violet, and an effective method of treatment of lupus vulgaris by concentrated ultra violet rays. He achieved considerable fame through the publication, in 1896, of his best known work on the employment of concentrated chemical light rays in medicine. He established a Light Institute in Copenhagen in April, 1896. He developed various types of lamps for the treatment of disease, some of which bear his name. Among these was particularly the blue-colored light still called the Finsen lamp. Finsen was awarded the Nobel prize in 1903. He was practically an invalid in the last few years of his life, and died on September 24, 1904.

FIONA MACLEOD. *See* SHARP, WILLIAM.

FIORD, a long, narrow, branching bay, through which the sea deeply penetrates adjacent mountain land. The coast of Norway is famous for its fiords. These, like the magnificent fiords of Alaska, are drowned valleys, first cut by streams, then deepened and widened by glacial ice before the subsidence of the coast. The Sognefiord extends inland 112 miles; at its deepest it measures 4,000 ft. In all Scandinavian fiords, the scenery is finest near the landward branches, where in places mountain walls rise sheer 3,000 to 5,000 ft. From hanging valleys, waterfalls tumble over high cliffs. Glacier tongues appear de-

scending from the vast snowfield of the Josteldalsbrae. Fiords are common in Greenland, Iceland, Spitzbergen, British Columbia, southern Chile, and Patagonia.

FIR, the common name for an important genus (*Abies*) of evergreen trees of the pine family. There are about 35 species, native chiefly of northern mountain regions, 10 of which are found in the United States, mostly on the Pacific coast. They are hand-

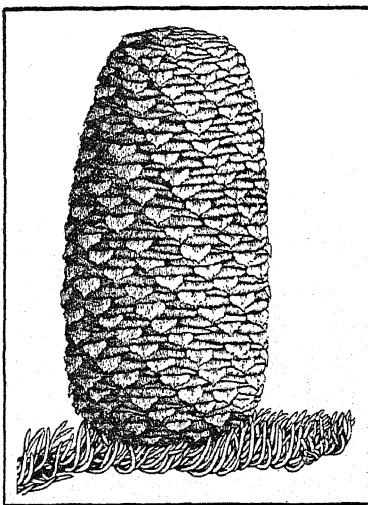


FROM JEPSON, MAN. FL. PLANTS CALIF., COPYRIGHT

WHITE FIR

Branchlet and cone, one-half natural size

some pyramidal trees, sometimes attaining immense size, with whorled and spreading branches, narrow flat leaves and large oblong cones, borne erect on the top side of the higher branches. The pale bark contains blister-like cavities filled with a clear, honey-like oleoresin. In North America only two native firs occur east of the Rocky Mountains, the balsam fir



FROM JEPSON, MAN. FL. PLANTS CALIF., COPYRIGHT

SHASTA FIR

(*Abies magnifica* var. *shastensis*). Branchlet and cone, one-third natural size

(*A. balsamea*), the source of Canada balsam, and the southern balsam fir (*A. Fraseri*), both rather small trees with balsamic foliage. The red fir (*A. magnifica*), of the Sierra Nevada, often grows 200 ft. high; the western silver fir (*A. amabilis*), of the Cascades and Olympics, the noble fir (*A. nobilis*), of

Washington, Oregon and California, and the white fir (*A. concolor*) found from the Rockies to the Sierras, all attain a height of 250 ft.; while the lowland white fir (*A. grandis*), of the Pacific northwest, sometimes reaches 300 feet. The wood of the firs, though usually much inferior to that of the pine or spruce, is used for lumber and pulpwood. The magnificent European silver fir (*A. alba*) and other Old World firs are planted for ornament. The so-called Scotch fir of the British Isles is a pine.

In 1930 the total cut in the United States of fir lumber, chiefly white fir, amounted to 207,494,000 bd. ft., valued at the mill at \$3,645,670. To this output California contributed 53%, Idaho 25.5%, Washington 12.4%, and Oregon 5.2% of the total. A. B. J.

FIRDAUSI or **FIRDUSI** (c. 940-1020), Persian poet, was born near Tus in Kharasan, about 940. His name is a pseudonym meaning Paradise. He passed his early years in intense study and research and then spent about 30 years in the production of his great masterpiece, the *Shah Nama* or *Book of Kings*, 1008. It is for this mighty epic of the Persian past that Firdausi has been called the Persian Homer. The *Shah Nama* is a poetical history of Persia from its legendary past down to Zoroaster, on to Alexander the Great's invasion and the vicissitudes of Persia up to the time of its downfall at the hands of Islam. A French translation of this work was made in 1831-68 at the expense of the French Government. Firdausi dedicated his epic to Sultan Mahmud of Ghazni and tradition states that when the Sultan failed of his promise to reward the author with a gold coin for every one of the 60,000 rhymed couplets, Firdausi in a rage went into voluntary exile only to return finally and die of a broken heart in his native Tus. The poet died in 1020.

FIRE ALARMS, signalling systems for calling out firemen and fire-fighting equipment to any vicinity in which a fire is discovered. Essentially, the fire alarm is a TELEGRAPH circuit with an automatic transmitting device at the sending end and a syphon recorder and gong at the receiving end. The signalling apparatus comprises a wheel driven by clockwork and having a certain number of notches so spaced as to actuate a lever which makes and breaks the circuit in the same manner as a telegraph key. Thus, if the wheel has two teeth, a space, three teeth, a space, then four teeth, the signal transmitted will be, or 234, the number of the alarm box from which the signal is sent. This transmitting wheel is set in operation by pulling a lever, access to the alarm box usually being gained by breaking a glass. The alarm box is generally equipped with a bell to notify bystanders and nearby policemen that an alarm is being given.

The alarm signal may be transmitted directly to the engine house or it may go through a central station, the latter being the case in large towns. When the central-station operator receives the signal he may send it to all the engine houses or only to those protecting the district concerned, depending upon the

system followed. This may be accomplished by an automatically or manually operated telegraph key or by TELEPHONE, the latter being employed when the telegraph is out of order. The signal is received at the engine house by a recorder and by gongs.

The alarm boxes are located at frequent intervals throughout a city so that one may be reached quickly from any point. Several of them are connected in series on the same loop, or circuit, and they are provided with an ELECTROMAGNET which keeps them from sending in an alarm until any other signalling box on the same circuit has completed its message, thus avoiding confusion of signals. Most alarm boxes are now equipped with a telephone which may be used by firemen in communicating with headquarters, with the police or with a hospital.

Systems of bells, usually operated by THERMOSTATS, are sometimes used in factories and schools, for fire alarms. These are usually connected to a near-by municipal alarm box to transmit the signal to the fire department.

The first municipal fire alarm system was installed in Boston in 1852.

FIREARMS. See GUN; PISTOL.

FIRE CLAY BRICK, brick made to resist high temperatures. It is manufactured from fire resisting clays by the hand made, soft mud, stiff mud, and dry press methods. The clays are obtained from both open pits and underground mines, made plastic by grinding and mixing with water, formed by process methods and dried and burned at 2200 to 2400° F. While made into many intricate shapes and sizes, the standard brick constitutes the chief volume. It measures $2\frac{1}{2} \times 4\frac{1}{2} \times 9$ in., and weighs about $7\frac{1}{2}$ lbs. Its color is mainly cream buff. It is used generally under high temperature conditions where the process is not decidedly basic or acid, e.g., in metallurgical furnaces and in the side walls in boilers. See also CLAY PRODUCTS.

L. C. H.

FIRE CONTROL, the operations necessary to the accurate and prompt delivery of ARTILLERY fire upon an enemy target. The actual aiming of the GUN at the target can be done either by pointing directly at the target by means of a sight or by indirect methods where the sight is pointed at some object in view, as a tree, laying the gun with direction of the target. To conduct such fire necessitates the exercise of those tactical and technical functions which determine the objective, the volume, the concentration and the accuracy of fire. Fire direction is the tactical command of one or more units with a view to concentrating or distributing their fire upon the proper targets at the appropriate time.

The following types of artillery fire are employed against an enemy: Destruction, fire concentrated on a material object to such an extent as to render it useless. Neutralization, fire of great intensity on personnel, with the object of causing severe losses, preventing movement or action. Harassing, fire of the same general nature as neutralization fire, but of less intensity; the object being, by inflicting losses or by

the threat of losses to disturb the enemy troops, curtail movements and in general lower morale. Counter-battery, fire on enemy artillery. Interdiction, fire placed on points or areas, as a road, which it is desired to prevent the enemy from using. Retaliation, fire executed at any time in retaliation for that placed on friendly troops. Counter-preparation, fire placed on probable enemy assembly areas. Registration, fire placed upon a known and selected point, either in or outside of enemy territory, to determine or check the corrections which must be applied to the gun settings before firing at an assigned target.

In firing at naval targets, elaborate fire control installations are necessary for plotting the present and future position of the ships. In general, use is made of observing instruments at the end of an accurately surveyed base line. These instruments at the base end stations are electrically connected with a central plotting room, usually at the location of the guns. By obtaining simultaneous readings from the base end stations, there is reproduced, in the plotting room, the track of the vessel. This permits the predicting of the future position of the target and laying of the guns accurately for range and direction. It is not necessary for the gun crew to see the target.

In antiaircraft fire control (see GUNNERY; ARTILLERY) it is necessary to have means whereby a target capable of moving in three dimensions may be instantaneously brought under effective fire. This is done by having a director into which there is placed instantaneous readings of the altitude of the plane. By keeping the director pointed at the plane the data for laying the gun are mechanically and electrically computed and set upon the guns. This makes it necessary only for the gun crew to load and fire the gun. No one at the gun is required to see the airplane. This permits of the guns being fired at a rapid rate of speed. With the modern director fire control system and the latest type of antiaircraft guns, it is practicable to furnish a proper and adequate antiaircraft defense for any selected area such as cities, naval bases and supply depots, either at day or night, powerful searchlights being used to illuminate the target at night.

In indirect fire, the firing data, including the deflection, elevation and range, are calculated at a point from which both the aiming point and the target and, if possible, the guns are visible. These data are determined by instruments, aiming circle, range finder and field glasses, or by estimation, as though the guns were located at the observation post. Then, the position of the guns being known with respect to that of the observation post, the data are corrected for the position of the guns. Sometimes the firing data are computed from a map, no observation post being used. See also RANGING.

S. J.

FIRE-CRACKER PLANT (*Brodiaea ida-maia*), a perennial of the lily family found in the foothills and mountains of northern California. The slender naked flower stalk, encircled by narrow root leaves, grows 1 or 2 ft. high bearing numerous showy flowers in a close cluster (umbel). The erect scarlet flower-

tubes, an inch or more long, persist after the blossoms have withered, giving the aging cluster an appearance somewhat resembling fire-crackers.

FIRE-CRACKERS. See FIREWORKS.

FIREDRILL, a primitive device for producing fire by friction. A stick usually about 9 inches long is revolved as rapidly as possible between the palms of the hands against a block of softer wood until a spark is produced at the point of contact. This method, with variations to increase the speed of rotation, is almost universally practiced by primitive peoples.

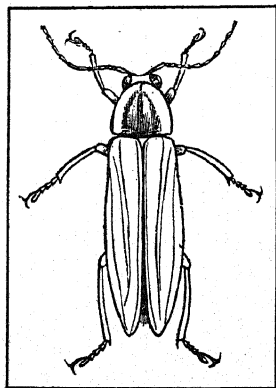
FIRE EATERS, a designation current before the Civil War for extremely partisan, obtrusively proslavery Southerners.

FIRE ENGINES, an ENGINE employed in pumping water to extinguish fires, consisting, until recent years of a vertical BOILER and a high-speed vertical steam engine driving plunger PUMPS. The assembly was mounted upon a horse-drawn four-wheel chassis. With the advent of the automobile (see MOTOR VEHICLES) the horses were replaced by an automobile tractor, or frequently a steam fire engine was mounted upon a specially designed automobile truck.

Modern fire engines no longer include a steam boiler and engine. Instead either the gasoline engine of the automotive truck is connected, through a clutch, to a centrifugal water pump or the truck carries a separate gasoline engine for the pump drive. The modern fire engine is vastly superior to the steam unit by reason of the rapidity with which it can be brought into action, its lighter weight and its greater water capacity.

L. H. Mo.

FIREFLY, certain beetles of the family *Lampyridæ*. The adults are soft-bodied nocturnal insects, small to medium in size. Larvæ, and adults of both sexes, may possess the power of emitting light. However, not all members of this family have light-producing organs. When present, these organs are located on the lower side of the abdomen near the end of the body. In one common species, this light-organ "is a modified portion of the fat-body in photogenic plate." Many fine tracheal branches surround it. A substance secreted by this photogenic plate is thought to burn rapidly in the oxygen abundantly provided. In efficiency, this light is 100% perfect. There is considerable evidence that this light is a means of helping the insects locate their mates. The larvæ and the wingless females of some species of fireflies are known as glow-worms.



FIREFLY
Photuris pennsylvanica

considerable evidence that this light is a means of helping the insects locate their mates. The larvæ and the wingless females of some species of fireflies are known as glow-worms.

FIRE HYDRANTS should be of simple and rugged construction, should operate freely and posi-

tively, should drain completely when closed and not leak when open. They should discharge with minimum loss of pressure and permit withdrawal of working parts from the top of the barrel without shutting the supply main. They may have one or two connections for fire hose, and usually have a six-inch connection to the main.

They are commonly located at street intersections, but are so situated as to allow the concentration of the necessary number of streams on any fire in any particular district. E. E. W.

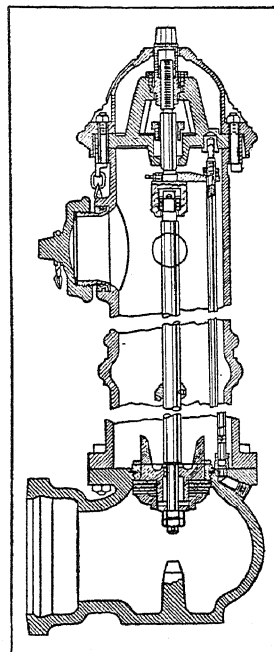
FIRE INSURANCE, an arrangement whereby indemnity against loss by fire is secured. There are two methods of securing protection: self-insurance and the purchase of an agreement to indemnify, or a fire insurance policy from a company organized to do this sort of business. The self-insurance method is possible only to large corporations which are financially able to assume their own risks; the second method is more generally used.

The fire insurance contract now issued by fire insurance companies is practically standard throughout the country. This is due to legislation on the part of the states and the cooperative work of the various associations of fire underwriters. It stipulates all the terms which generally cover the agreement to indemnify and is adapted to each individual risk by the addition of endorsements, or riders, which describe the property, specify the insurable interest in it and otherwise cover the details peculiar to that risk.

Because of the wide variation in types of hazard presented by various properties, an elaborate schedule of premium rates has been devised. It classifies the various risks on the basis of type of building, how used, its contents, its surroundings and the fire protection available. This schedule, combined with the experience tables which all insurance companies have on hand, comprises the basis for calculating premium charges; local inspection, by the fire insurance agent or by an employee of the underwriters association, completes the calculation. Losses are settled on the basis of damage done by the fire and are based on proof of loss statements which are filed by the insured.

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FIRELESS COOKERY, cooking done in an insulated, closed compartment which conserves the heat.



CROSS SECTION OF FIRE
HYDRANT

Formerly, the food was brought to the proper temperature over a fire and then transferred to the fireless cooker which was provided with a stone which might be pre-heated. Modern fireless cookers, however, are equipped with an electric heating element, which brings the food to the desired cooking temperature. In certain designs, the current is shut off automatically at a pre-determined time.

FIRENZE. See FLORENCE.

FIRE PREVENTION, activities designed to reduce the losses occasioned by fire. During recent years the fire loss in the United States has been in the neighborhood of \$500,000,000 annually, accompanied by the death of nearly 10,000 persons. This constitutes an economic waste nearly ten times greater than that of any other nation, a waste to which is added a charge of almost the same amount for buying and maintaining fire fighting equipment. Aggressive campaigns are therefore continually being waged with the idea of preventing fires.

Legislation is one of the principal methods of combating the fire hazard. Practically every state has enacted laws designed not only to compel the construction of fireproof buildings but to reduce the hazard inherent in those structures which have already been erected. Some states have created the office of State Fire Marshall, the appointee being charged with the duty of inspection and correction, in some cases being empowered to condemn and destroy properties which are a menace. Municipalities back up this effort with constant inspections made by their fire fighting forces, in such a manner removing conditions which are likely to produce fires.

Education is another method of prevention, the campaigns being sponsored by national associations of fire underwriters with the idea of reducing the cost of FIRE INSURANCE. These campaigns begin with lectures delivered to school children by fire officials, who point out the evils of carelessness and untidiness and instruct them as to how, by simple methods, fires may be prevented. Literature of all sorts is provided, even plays are written, and the entire campaign is pointed up by the celebration of National Fire Prevention week. That such campaigns are well worth while has been proved by the fact that in localities where the campaigns were waged, the fire loss has been reduced by as much as 20%.

Marine Fire Prevention. Vessels are required by law to carry various fire fighting apparatus, and equipment, and also to observe regulations pertaining to the cargoes carried and the way they are stowed. Furthermore, the officers and crew must know their duties and stations to go to in case of fire, and are drilled at stated times.

The fire fighting apparatus includes fire pumps, and a complete water distributing system including fire main, hose connections and coils of hose all ready for immediate use. Water pails, axes and chemical fire extinguishers are installed at parts of the vessel as required.

Hold: designed to carry inflammable cargoes may

be equipped with a water system, in which are valves that automatically open when the temperature reaches a certain degree. Or they may be equipped with one of several patented fire indicating and extinguishing systems. For instance, in one, if the temperature of the hold reaches a given temperature, a signal is at once flashed in the pilot house, giving the location of the hold. For extinguishing fires, instead of using water, a chemical substance is let loose, which forms a blanket over the fire, tending to smother it.

FIREPROOFING may be described as the means by which combustible or inflammable materials are protected from the effects of fire. This protection is a relative one and in building materials the various materials and methods used for fireproofing purposes are rated as one hour protection, two hour protection, etc., depending upon the effectiveness of the fireproofing when subjected to certain standard tests.

Structural steel is ordinarily fireproofed with CONCRETE, clay tile, brick or gypsum. Re-enforcing bars are naturally fireproofed by the concrete which they re-enforce. Wood, which is used in high-building work, is treated with certain chemicals for the purpose of making it fireproof.

G. A. H.

Fireproofing of combustible textiles reduces the flammability of the materials, but does not afford a complete protection against fire. The methods now in use fall into three classes: for clothing, which must be washed; for decorative hangings as theater curtains, which will not be washed; and for fabrics which must withstand weather. The tungstic acid process, now rarely used, alone meets the requirements for clothing. Fireproofing of textiles to be used indoors employs soluble silicates, phosphates, borates and carbonates which form a coherent slag or glass on the fiber at a rather low temperature which impedes flame or live coals and holds the charred fibers quite strongly in place, especially if the fabrics are loaded with China clay. Fabrics so treated are harsh and stiff.

Fabrics which must withstand the weather are treated with precipitated silicates, phosphates, litharge and boric acid compounds of low solubility, either alone or together with high melting-point asphalts or bitumens. Impregnation or coating with chlorinated hydrocarbons delay ignition but those compounds vaporize at moderate temperatures and do not form slags. Treatment with them is, therefore, not truly fireproofing but it does reduce the risk of ignition. Fireproofed fabrics are generally used for mine brattice cloths and are required by law for theatrical scenery.

W. H. A.

FIRE PROTECTION. The general risk of disastrous fires in any community is dependent upon the type and compactness of building construction, the spacing and width of streets, and the presence of special hazards occasioned by the storage of oil or other inflammable material. The total quantity of water which should be available for fire service in the average city with a population of 200,000 or more, has been estimated at from 14,000 to 20,000 gallons per

minute over a period of ten hours. A number of the larger American cities have installed separate systems of high pressure water mains in their congested districts because the conflagration possibilities far exceeded the protective facilities available from the general WATER SUPPLY system. With a high pressure fire system a large number of powerful streams can be concentrated on a fire in a much shorter time and with fewer men and less apparatus than with the ordinary water system, while the protection of the rest of the city is not weakened as it is now when a second, third, or general alarm is sent out from the congested district. E. E. W.

FIRE THORN (*Pyracantha*), a small genus of thorny, evergreen shrubs of the rose family native to Europe and Asia, several of which are planted for ornament. The common fire thorn (*P. coccinea*), an attractive shrub planted for hedges and occasionally escaped in the eastern United States, grows sometimes 20 ft. high, bearing numerous finely-toothed, leathery leaves, about 2 in. long, white flowers and small, pome-like, scarlet fruits.

FIREWEED, a name given in the United States to various plants which quickly spring up in burned-over clearings. Among the plants so named is the tall fireweed (*Epilobium angustifolium*), called also great willow-herb, found across the continent. It is a handsome plant, bearing willow-like leaves and large showy clusters of purple flowers. In the eastern United States *Erechtites hieracifolia*, a hairy plant of the composite family, is also known as fireweed. The Australian fireweed (*E. prenanthoides*) and the New Zealand fireweed (*E. arguta*) have been recently introduced into California.

FIREWORKS, a pyrotechnic display produced in celebration of some event, for signalling, or for temporary illumination. The common types of fireworks include: set pieces, which fire off showers of colored flame or sparks, being frequently arranged to form elaborate pictures of fire in the air; Roman candles, which hurl colored stars or bombs into the air; rockets, which are carried into the air by a rearward explosive discharge, exploding in midair to throw out a shower of sparks or fire; pinwheels, which discharge products of combustion from tangential tubes, rotating the wheel and producing its effect, a wheel of fire; fire-crackers, comprising a small charge of gunpowder which is ignited by a fuse to make a noise; torpedoes, which consist of an explosive that is set off on impact with a hard surface; parachute flares, shot into the air like rockets and producing a brilliantly colored fire while descending.

FIRST-AID. The purpose of first-aid treatment is to avoid the occurrence of complications, to prevent infection, to check bleeding, and in any other way relieve symptoms until more thorough treatment is administered. In the case of minor cuts, first-aid consists in the application of some antiseptic, such as tincture of iodine (see IODINE) or a solution of MERCURIOCHROME, and covering the wound with a clean bandage. Where there is *bleeding*, it may be checked by

pressure, or the use of a tourniquet where possible. In the more superficial wounds, if the blood flows in spurts, an artery is injured and pressure must be made above the wound or between it and the heart. If the blood flows steadily and smoothly, a vein has been cut and pressure should be made on the side farthest from the heart. A tourniquet is made by tying a handkerchief around the bleeding part, if a limb, inserting a stick or pencil between it and the limb, and twisting until tight and the bleeding is controlled.

In the case of broken bones, the part should be held rigid by putting on a splint. The limb should not be strapped or tied to the splint so tightly as to obstruct the circulation. (See FRACTURES.)

In the case of *gas poisoning*, the individual should be removed from the poisonous atmosphere and placed in fresh, but not cold air. Chilling should be carefully avoided. The individual should be wrapped in blankets. Artificial respiration should be applied as soon as possible. (See ARTIFICIAL RESPIRATION; ASPHYXIATION; GASES AND ATMOSPHERES, INJURIOUS.)

In other types of poisoning, first-aid consists in producing vomiting as soon as possible. Tickling the throat, or putting the fingers into the throat to cause gagging, may be sufficient to induce vomiting. Mustard-water may be used. In mercury poisoning, egg-white should be given. In poisoning from acids, an alkaline substance can be given, and in poisoning with strong acids an acid substance such as lemon juice or vinegar may be valuable. (See ANTIDOTES.) For first-aid in *drowning*, see ARTIFICIAL RESPIRATION. For first-aid in *electric shock*, see ELECTRIC SHOCK; ARTIFICIAL RESPIRATION.

FIRTH, SIR CHARLES HARDING (1857-), English historian, was born at Sheffield, Mar. 16, 1857, and educated at Clifton College and Balliol College, Oxford. In 1883 he became engaged in literary and historical work at Oxford; he was the Regius professor of modern history from 1904-25 and was made professor emeritus in 1925. His principal interest is in the 17th century. In this field he has written *Scotland and the Commonwealth*, 1895; *Oliver Cromwell*, 1900; *Scotland and the Protectorate*, 1899; *Cromwell's Army*, 1901; *The House of Lords during the Civil War*, 1910. Other works are *The Clarke Papers*, 4 vols., 1891-1901; *Ludlow's Memoirs*, 1894, and *The Life of the Duke of Newcastle*, 1886. His influence in the development of historical scholarship and writing among the present generation has been very considerable.

FISCAL POLICY, a government's financial policy, particularly as regards public revenues. In its broadest meaning it should include the policy in reference to tariffs, particularly protective tariffs (see PROTECTION), the safeguarding of industry, graduation of taxes, public borrowing and the like.

FISCAL YEAR, a period of 12 months set aside by commercial houses and governments during which accounts are reckoned and at the end of which books are closed and the financial status determined. It does not necessarily coincide with the calendar year,

but unless otherwise specified it is taken as ending on Dec. 31. Business houses arbitrarily set the dates for their respective fiscal years.

FISCHART, JOHANN (c. 1545-c. 1591), German poet and satirist, was born at Mainz, about 1545. He studied law, traveled in England and on the Continent, was associated with his brother-in-law's printing business in Strassburg, and late in life held public office in Forbach. He produced a number of satirical masterpieces of invective that have established his fame as a champion of the Reformation and a prophet of intellectual and political freedom in Germany. Fischart's works are typical of the intellectual ferment of the Reformation. He attacked hypocrisy in religion, pretension among the learned and pettiness and cant wherever found. His most famous work is an imitation of Rabelais' *GARGANTUA*, in which he completely Germanized and assimilated the original. This work attacks monasticism and scholastic education and ends with a prophecy of the final emancipation of intelligence. It is, in short, an astounding mixture of vulgarity and sublimity. His other polemical satires are also well worthy of study as typical of the generation following the death of Luther. Fischart died at Forbach, near Saarbrücken, about 1591.

FISCHER, EMIL (1852-1919), German chemist, was born at Euskirchen Oct. 9, 1852. He was professor of chemistry successively at Munich, Erlangen, Würzburg and Berlin and was a most fruitful research worker in organic chemistry. His work is fundamental in derivatives of hydrazine, phenyl hydrazine, rosaniline dyestuffs and almost all modern knowledge of the purines is from Fischer. In 1902 he was awarded the Nobel prize in chemistry. Later he turned his attention to the sugars, synthesizing a great number. This necessitated his studying problems of fermentation and his work upon enzymes proved the foundation of that branch of chemistry. He likewise succeeded in breaking down proteins into amino acids. During the World War his work in organizing the German chemical industry was of enormous value. He died at Berlin, July 15, 1919.

FISCHER, ERNST KUNO BERTHOLD (1824-1907), German historian of philosophy, was born at Sandewalde, Prussia, July 23, 1824. He studied at the universities of Leipzig and Halle, was instructor at Heidelberg, professor at Berlin and Jena, and in 1872 was called to the chair of philosophy and history at Heidelberg. His fame rests on his brilliancy as a historian of modern philosophy. The most important among his works are: *History of Modern Philosophy*, 1897-1901, and *System of Logic and Metaphysics*. Fischer died at Heidelberg, July 4, 1907.

FISCHER VON ERLACH, JOHANN BERNARD (1656-1723), Austrian architect, was born at Gratz, in July 1656. He appears to have studied in Italy and returned to Vienna towards the end of the 17th century. Here he soon became one of the recognized masters of German Baroque style. In 1696 he was commissioned to draw the plans for the Imperial Palace of Schönbrunn. In Prague he built the

Clam-Gallas Palace, at Breslau the Electoral Chapel of the Cathedral, at Salzburg the Collegiate Church, and at Vienna the Trautson Palace, the palace of Prince Eugene, St. Peter's Church, and toward the end of his life began the Church of St. Charles Barromeo, a work completed after his death by Martinielli. He died at Vienna, Apr. 5, 1723.

FISH, HAMILTON (1808-93), American statesman, was born in New York City, Aug. 3, 1808. He was graduated in 1827 from Columbia College, and in 1830 was admitted to the bar. From 1843-45 he served as a Whig member of Congress, from 1849-51 as Governor of New York and from 1851-57 as U.S. Senator. From 1861-62 he was a member of the Union Defense Committee to furnish troops and relieve the volunteers of New York City and their dependents. With Bishop Ames in 1862 he arranged the system for exchange of prisoners which was used throughout the Civil War. President Grant appointed him Secretary of State in 1869. In this position he conducted negotiations with England which culminated in the Washington Treaty of 1871. That same year he presided at the Washington Peace Conference between Spain and the South American republics. He represented this government in the northwestern boundary dispute between the United States and England, and successfully settled the Alabama Claims against Great Britain. In the diplomatic service he was responsible for reforms which eventually required civil service examinations of candidates for consular positions. The post of secretary of state he held until 1877. He died at Garrison, N.Y., Sept. 7, 1893. See also GRANT, ULYSSES SIMPSON.

FISH, EDIBLE. The many varieties of fish may be classified as true or vertebrate fish and shellfish. The former vary considerably in size, color, shape and other characteristics. Some contain very little fat (less than 2%), as cod and haddock; others, such as halibut, mackerel and white fish, are medium-fat (2 to 5%), while some are distinctly fatty (more than 5%), e.g., turbot, salmon and herring. The shellfish include the crustaceans (lobsters, crabs and shrimps) and mollusks (oysters, clams and scallops).

Fish must be perfectly fresh to be eaten safely, since it deteriorates very rapidly. Fresh fish is firm to the touch, has moist scales and bright eyes and skin, and is free from any unusual or unpleasant odor. If kept in cold storage chilled to ice temperature, or if frozen while perfectly fresh and kept frozen until just before cooking, fish will retain its freshness and flavor for some time. It is reported that tests showed no appreciable change in composition, food value, or sanitary condition in fish frozen for two years.

Many kinds of fish are canned, the most popular varieties being salmon, tuna, lobster, crab, cod and sardines. Usually they are more or less completely boned before canning. Some fish are preserved by salting, drying or smoking or a combination of two or all of these methods, e.g., cod, herring and sardines.

Oysters and other shellfish are often "floated" in fresh water or water containing less salt than that in

which they were grown. This causes them to absorb water and increase in size, and is considered an adulteration under Federal and certain state laws, unless labelled "floated." The danger lies in contamination if the water is impure. There is the same risk if shellfish are grown in polluted water.

The roe (eggs) of shad, cod and other fish is eaten fresh. Caviar is salted sturgeon roe. The best grades come from southern Russia.

The composition of fish, in general, is quite similar to that of lean meat and poultry, except that the flesh of fish contains more water and less fat and nitrogenous extractives (substances which help to give meat and meat extract their flavor and stimulating qualities). Contrary to popular theory, fish contains no more phosphorus than meat and is not a specific "brain food." Both meat and fish contain about the same quantities of most other minerals and vitamins. Proteins of both are about equally efficient in building and repairing body tissues. Lobster, crab, clams and oysters are unique among flesh foods in that they contain some carbohydrate (glycogen).

Fish is digested about as completely as meat. Oysters and lean fish leave the stomach slightly more rapidly than lean beef, while fat fish, and crab and lobster require about the same time as ham and pork.

H. T. B.

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FISHER, ANDREW (1862-1928), Australian statesman, was born at Crosshouse, Kilmarnock, Scotland, Aug. 29, 1862. He first worked in a coal mine, and in 1885 moved to Queensland, Australia, where eight years later he was elected to the legislature. In 1901 he was chosen a member of the Commonwealth Parliament, and ultimately made leader of the Labor Party. He served twice as prime minister. Fisher died in London, Oct. 22, 1928.

FISHER, DOROTHY CANFIELD (1879-), American novelist, was born at Lawrence, Kan., Feb. 17, 1879. She was graduated from the Ohio State University in 1899 and obtained her Ph.D. degree at Columbia University in 1904. Among Mrs. Fisher's novels are *The Squirrel Cage*, 1912, *Hillsboro People*, 1915, *The Bent Twig*, 1915, *The Brimming Cup*, 1921, *Rough Hewn*, 1922, *The Homemaker*, 1924, and *The Deepening Stream*, 1930. In 1921 she published her well-known translation of Papini's *Christ* from the Italian.

FISHER, HERBERT ALBERT LAURENS (1865-), English statesman and educator, was born in London, Mar. 21, 1865, and educated at Winchester, New College, Oxford, Paris and Göttingen. He was president of the Board of Education, 1916-22; member of the Royal Commission on Public Services in India, 1912-15; vice-chancellor of the University of Sheffield, 1912-16; delegate to the League of Nations, 1920-22, and warden of New College, Oxford, 1925. He has published *Napoleonic Statesmanship*, 1903; *Bonapart-*

ism, 1908; *Life of F. W. Maitland*, 1919; *The Republican Tradition in Europe*, 1911; *Napoleon Bonaparte*, 1913; *Life of Sir Paul Vinogradoff*, 1927; *Whig Historians*, 1928; *Our New Religion*, 1929.

FISHER, IRVING (1867-), American economist, was born at Saugerties, N.Y., Feb. 27, 1867. Completing his education at Yale University and in Berlin and Paris, he joined the Yale faculty as professor of political economy in 1898. He was editor of the *Yale Review* in 1896-1910, and was president of the American Association for Labor Legislation during 1915-17, the American Economic Association in 1918, and the Eugenics Research Association in 1920. In 1917 he became chairman of the subcommittee on alcohol of the Council of National Defense, and in the same year was president of the Citizens' Committee on Wartime Prohibition and of the Committee of Sixty on National Prohibition. He was one of the foremost proponents of Prohibition in the United States, and in 1926 and 1929 published volumes in support of the 18th Amendment. His volume, *The Money Illusion*, published in 1928, was translated into French, German, Polish and Dutch.

FISHER, SIR JOHN ARBUTHNOT (1841-1920), First Baron of Kilverstone, British admiral and naval expert, was born at Rambodde, Ceylon, Jan. 25, 1841. He entered the navy in 1854, took part in the Crimean War, 1854-6, the China War, 1859-60, and commanded the *Inflexible* at the bombardment of Alexandria in 1882. He became one of the admiralty lords in 1892, commander-in-chief of the Mediterranean fleet in 1899-1902, and first sea lord during 1904-10 and 1914-15. He is credited with formulating the policy in the North Sea which blocked the German fleet during the World War, and with the victory of the Battle of Falkland Islands, Dec. 8, 1914. He resigned from the admiralty in 1915, after differing with Winston Churchill, first lord of the admiralty, as to the wisdom of the Dardanelles campaign, and for the remainder of the war served as chairman of the Inventions Board. He died in London, July 10, 1920, and was honored by burial in Westminster Abbey.

FISHER (*Mustela pennanti*), variously called Pennants' marten, pekan, wejack, black-fox and black-cat. As its natural prey are not fish but small land creatures, the name fisher seems to have been given it because it devours the fish used as bait for other animals. With the exception of the wolverene, it is the largest of the North American carnivorous quadrupeds of the weasel family, being over 2 ft. long beside the tail, which adds another foot or more. It occurs throughout Canada and western United States as far south as Texas, wherever the country is still forested and unsettled. The general color is dark brown with gray head and neck. The light patch that marks the throat of the other weasels is absent. It is fierce, nocturnal and arboreal, and is trapped for its skin in winter.

FISHERIES, a term covering the operations of man in taking from fresh and salt water such aqua-

tic creatures as have economic value. In addition to fish, these include coral, sponges, pearls, tortoise-shell, *bêche de mer*, shark and porpoise leather and shark fins. The term also covers whaling, sealing and similar activities.

Fish are a universal and important food, especially to those nations which cannot afford to give up the land necessary to raise animals for food, as well as to those where religion forbids the taking of animal life. For instance, Japan leads the world in the total annual value of its fisheries, and while accurate figures are not available for China, it is known that the catch and consumption of fish in that country is enormous. In general, fish plays a most important part in the diet of rice-eating peoples.

The total value of the annual fish catch of the world cannot be accurately estimated, but available figures indicate that it runs over \$1,000,000 a day. So far, this great harvest of the sea has been taken without thought of the future. Fishing has been based on hunting rather than husbandry, but the lessening in the take of certain valuable species and the apparent exhaustion of some of the older fishing grounds, makes it almost certain that regulation and control must be worked out by the civilized nations of the world. Experiments in pisciculture, as far as salt-water fish are concerned, have not been over-successful, and though billions of eggs and millions of fingerlings have been planted in certain fishing grounds, no apparent increase in the number of fish on these grounds has been noticed.

Primitive man possibly showed more ingenuity in fishing than anything else, and it is certain that fish and mollusks took an important place in the diet of most pre-historic peoples. Hooks, weirs and nets were all invented before the dawn of history and our modern fishing equipment is merely an improvement on theirs.

Although three-fourths of the world is covered by water, fishing is limited to those waters with a depth of not more than a hundred fathoms and the greater part of it is done in much shallower depths. In general, all fishing is done on the great shelves which surround the various continents. One reason for this is the depth of water, another the fact that rivers are constantly bringing soil to the sea. The greatest fishing grounds in the world are those of the North Sea and the Grand Banks of Newfoundland. In the North Sea, the rapid streams of the Scandinavian peninsula and of Great Britain are constantly pouring fresh soil over the bottom on which grows the vegetation eaten by the many economically important species of fish taken there. Similarly, icebergs from Greenland, melting and depositing soil on the Grand Banks, produce the same result.

At present, the great fisheries of the world are those of the North Sea, the waters off the coasts of Ireland, Scotland and England, Iceland and the Faroe Islands, the Mediterranean, the Banks of Newfoundland, the Atlantic and Pacific coasts of the United States and the seas around Japan. There can be no

question but that new fishing grounds, especially in the warmer waters, will be developed as those in the northern oceans become more fished out. The waters around the West Indies and those of the Gulf of Mexico, for example, are known to teem with edible fish, many of which, though not generally known as food fish, could be of great commercial importance. The tuna fishing industry on the Californian coast is an example of a fishery that has been developed only in the 20th century, but will undoubtedly be extended to other southern waters in years to come.

To a great extent, the handline has given way to the gill, purse and seine nets, and the beam and otter trawls. There are still, however, many fishing schooners going from Gloucester and other New England fishing towns to the Newfoundland Banks, the crews of which fish with handlines from dories, the fish being cleaned and salted each day and the ship remaining on the Banks until the hold is filled. In some cases, fast carriers take the catch from several boats on the Banks and hurry it, packed in ice, to the home port, whence it is shipped, frozen and still fresh, to inland cities. Recently, experiments have been made on the Grand Banks with large ships which are equipped to preserve the fish on board, the refuse being cooked down for fertilizer.

Since fish spoil very easily, the problem of preserving has been great, and several methods have been worked out. Probably the oldest in use is that of salting and drying. This is applied especially to cod, haddock, hake and other of the larger fish. The fish are usually cleaned and split open and the backbone removed, then rubbed with salt and packed in the ship's hold without being iced. Ashore, they are dried on racks in the sun; these drying racks are a point of interest in every fishing town along the Atlantic coast of Canada and the New England states.

Herring are usually pickled in brine, though some are slightly salted and then smoked. Mackerel are pickled, salted and smoked. In general, the species which take smoking best are the oily fish, such as mackerel, herring, haddock, salmon and halibut.

Fish that are canned may be plain boiled or steamed, or may be canned in oil or with sauces. In the United States, far more salmon are canned than any other sea product, although the tuna canning industry has progressed rapidly in recent years, and the canning of oysters has long been a large industry. Clams are canned and also clam broth. Codfish cakes and clam chowder are among the newer ocean products put up in tin. Lobsters, shrimps and crabs are preserved in both tin and glass. A recent industry developed by several plants on the Pacific coast is the canning of whale beef, for which a steady sale has been built up. It remains to be seen whether or not whale beef will ever become a staple food. The refuse from fish canning plants is made into meat scrap and bone grit for poultry food.

More fish are preserved by freezing than by any other method. Because of modern methods and

through the use of refrigerator cars, fish are now shipped all over the country and the farmer in the corn belt can have fish as fresh and good as those bought in cities along the Atlantic coast. Several methods of freezing are in vogue. The older system is to pack the fish in suitable sized pans, and fill these with water which is frozen by the use of ammonia or salt and ice. When removed from the pan, the frozen block of ice and fish may be shipped great distances without loss of firmness or tenderness. The more modern method of freezing requires an extremely low temperature, usually secured by carbonic acid gas ice, which has a temperature of 130° below zero. Frozen almost instantaneously, the tissue

cells are not disrupted, and when thawed out, the fish is in exactly the same condition as before. On the Atlantic coast, bluefish, halibut, weakfish, sturgeon, mackerel, flounders, cod, haddock, swordfish, red snapper, Spanish mackerel, porgies and eels are preserved in this manner; on the Pacific coast, salmon, halibut and sturgeon; and on the Great Lakes, lake trout, lake herring, wall-eyed pike, perch, whitefish, black bass and sturgeon.

The total catch of fish and fish products for 1930 divided according to the eight important sections supplying the domestic markets and expressed in thousands of pounds and thousands of dollars was as follows:

Products	New England		Middle Atlantic		Chesapeake		South Atlantic and Gulf	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Fish	646,541	20,881	120,025	3,733	169,065	4,633	375,963	7,402
Shellfish, etc.	47,745	8,191	70,748	10,405	105,609	6,948	159,432	7,502
Whale products .....	..	..	..	..	..	..	..	..
Total	694,286	29,072	190,773	14,138	274,674	11,581	535,395	14,904

Products	Pacific		Mississippi River and tributaries		Lakes		Alaska		Total	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Fish	1,012,729	23,097	53,466	3,310	77,922	6,434	640,490	16,465	3,096,201	85,955
Shellfish, etc.	16,167	1,572	47,437	1,139	7,467	354	2,008	117	456,613	36,228
Whale products	5,538	369	..	..	..	..	8,925	502	14,463	871
Total ..	1,034,434	25,038	100,903	4,449	85,389	6,788	651,423	17,084	3,567,277	123,054

The annual oyster take was formerly the most valuable of all the fish catches of the United States. In 1930, however, the salmon catch took first place among the fisheries of this country. Other leading catches include those of cod, haddock, mackerel, tuna and shrimp. The statistics of the U.S. Bureau of Fisheries for the fiscal year of 1930 show that there were 48 fish and shellfish catches having an annual value of over \$400,000 as follows:

Species	Quantity-lbs.	Value
Alewives	35,290,000	\$ 434,000
Barracuda	5,246,000	531,000
Bluefish	6,796,000	616,000
Buffalofish	17,333,000	1,018,000
Butterfish	14,248,000	977,000
Carp	22,354,000	1,104,000
Catfish and Bullheads	16,347,000	1,190,000
Chubs	5,601,000	589,000
Cod	116,652,000	3,541,000
Croaker	27,720,000	645,000
Flounders	75,329,000	3,479,000
Haddock	261,655,000	9,142,000
Hake	27,153,000	619,000
Halibut	55,297,000	6,413,000
Herring—sea	262,258,000	1,859,000
Herring—lake	20,596,000	569,000
Lake Trout	11,949,000	1,745,000
Mackerel	122,094,000	3,277,000
Menhaden	393,405,000	2,148,000
Mullet	33,816,000	1,340,000
Pilchard	651,802,000	3,588,000

Species	Quantity-lbs.	Value
Salmon, sockeye	165,718,000	\$6,122,000
“ king	50,137,000	5,032,000
“ chum	107,274,000	1,796,000
“ pink	221,918,000	5,507,000
“ silver	39,448,000	2,002,000
Scup	12,305,000	401,000
Shad	17,234,000	2,468,000
Snapper	9,987,000	822,000
Spanish mackerel	6,314,000	405,000
Squeteague	33,765,000	1,846,000
Striped Bass	2,619,000	422,000
Swordfish	7,086,000	1,031,000
Tuna—all kinds	75,188,000	3,911,000
Whitefish	10,334,000	1,701,000
Yellow Perch	8,364,000	498,000

Among the important by-products of the fisheries were marine animal oils, 14,704,784 gals. valued at \$4,200,064, consisting of chiefly cod liver oil 151,451 gals., herring and sardine oil 9,500,019 gals., menhaden oil 3,197,265 gals., salmon oil 233,941 gals., tuna oil 56,748 gals., and whale oil 1,325,299 gals.; also oyster shell products, 347,056 tons, valued at \$2,595,252.

That the fisheries of the United States employ a surprisingly large number of men is shown by the fact that in 1930 there were 123,145 men employed afloat and ashore, using when afloat 18,029 vessels and boats, with a total tonnage of 175,553. These men and vessels were divided among different sections of the country as follows:

FISHERIES

<i>Items</i>	<i>New England</i>	<i>Middle Atlantic</i>	<i>Chesapeake</i>	<i>South Atlantic and Gulf</i>	<i>Pacific</i>	<i>Mississippi River and tributaries</i>	<i>Lakes</i>	<i>Alaska</i>	<i>Total</i>
	Number	Number	Number	Number	Number	Number	Number	Number	Number
Fishermen:									
On vessels	6,199	4,787	2,586	3,298	5,822	...	1,769	10,921	35,382
On boats and shore	10,961	5,704	15,884	23,345	14,170	12,310	5,390	..	87,764
<i>Total</i>	17,160	10,491	18,470	26,643	19,992	12,310	7,159	10,921	123,146
Vessels:									
Steam	55	19	30	...	7	...	122	8	241
Net tonnage	8,805	2,556	3,118	...	283	...	2,712	617	18,091
Motor	671	479	95	524	783	...	378	726	3,656
Net tonnage	17,589	6,973	1,120	8,961	17,687	...	3,988	11,992	68,310
Sail	5	85	281	90	9	...	...	...	470
Net tonnage	36	2,170	3,101	1,388	3,392	...	...	...	10,087
<i>Total vessels</i>	731	583	406	614	799	...	500	734	4,367
<i>Total net tonnage</i>	26,430	11,699	7,339	10,349	21,362	...	6,700	12,609	96,488
Boats:									
Motor	5,093	1,800	7,915	6,837	6,033	4,597	2,078	1,861	36,214
Other	6,524	2,596	5,500	10,704	1,626	10,941	1,401	3,559	42,851
Total boats and vessels	38,047	16,095	20,754	27,890	29,021	14,538	10,179	18,029	175,553

Over 4,000 persons were engaged in transporting fish and fish products, using 1,434 vessels and boats with a total tonnage of 67,022, distributed in steam, motor and sailing vessels as follows:

<i>Items</i>	<i>New England</i>	<i>Middle Atlantic</i>	<i>Chesapeake</i>	<i>South Atlantic and Gulf</i>	<i>Pacific</i>	<i>Mississippi River and tributaries</i>	<i>Lakes</i>	<i>Alaska</i>	<i>Total</i>
	Number	Number	Number	Number	Number	Number	Number	Number	Number
Transporting:									
Persons engaged	404	100	855	757	310	27	77	1,716	4,246
Vessels:									
Steam	2	..	2	...	1	..	6	24	35
Net tonnage	67	..	175	...	32	..	220	32,415	32,909
Motor	148	32	418	152	119	13	30	390	1,302
Net tonnage	1,878	511	5,296	1,461	2,383	214	364	14,261	26,368
Sail	4	..	45	41	5	..	..	2	97
Net tonnage	443	..	1,527	402	1,818	..	..	3,555	7,745
Total vessels	154	32	465	193	125	13	36	416	1,434
Total net tonnage	2,388	511	6,998	1,863	4,233	214	584	50,231	67,022

It should be noted that the figures on the annual fish catch of the United States given in this article do not include the game fish caught each year by sportsmen. This runs into millions of pounds, since over 5,000,000 fishing licenses are issued to sportsmen each year.

In recent years there has been a marked development of the fish-farming pond-fish industries, with an increasing number of establishments devoted to the commercial production of trout, and also of various pond-fish, as black bass, sunfish, crappie, catfish, yellow perch and pickerel. In 1931 there were upwards of 200 such establishments, distributed in 20 states, but most numerous on the Pacific Coast and in Colorado, New York, Pennsylvania and Massachusetts. In addition about 20,000,000 goldfish, reared for ornamental purposes and valued at approximately \$1,000,000, are produced annually by breeders. The total value of products marketed yearly by the fish-farming industries of the United States exceeds \$2,-

000,000. In 1929 the fish sold for food were valued at \$589,554.

The U.S. Bureau of Fisheries not only supervises the various fishing grounds, but collects and furnishes in printed form, various statistics regarding fish and other aquatic products, including oysters, clams, shrimp, sponges, whale oil and other products, shark and porpoise leather, agar-agar, shark fins, tortoise and terrapin, oyster shells for poultry grits, mussel shells for pearl button making, etc. From its laboratories at Woods Hole, Mass., Key West, Fla., Beaufort, N.C., and Fairport, Iowa, as well as from a number of sub-stations, it distributes both fish eggs and fingerlings, the number in 1930 amounting to over seven billion eggs and fingerlings. The Bureau also investigates and determines upon better marketing methods and improved distribution of fish product. Most of the states have conservation agencies of one kind or another with which the U.S. Bureau operates most closely.

A. R. F.

FISHERMAN, one whose occupation is to catch and market fish. The fisherman is trained only by actual experience and is usually born into the life. Hardihood, courage, and a love of the sea are his prime requisites. The compensation of a fisherman is dependent on the size and market value of his catch. Modern methods of fish trapping, netting and trawling have, in many instances, robbed this occupation of much of its individual initiative and now fishermen are frequently the employees of large corporations. When fishermen work on steam-trawlers, they differ only slightly from sailors.

FISHES. Fishes are bilaterally symmetrical, back-boned animals, with a skull, a highly complex brain, a heart of three or four chambers and red corpuscles. In these and other fundamental details they agree with all of the higher animals. Their single pair of lense-bearing "camera" eyes is also essentially the same as in all vertebrates; and the two sets of paired fins which they normally possess are comparable (homologous) with fore and hind limbs. However, they never have any structure comparable with the digits, fingers or toes, characteristic of every higher form from frog to man.

Fishes are aquatic, and breathe by means of gills throughout life. Their every habit and structure is an adaptation to aquatic life. They are the highest in the evolutionary scale of any thoroughly aquatic animal; and the waters are their domain. At the same time all the back-boned land animals are more or less directly or indirectly descended from some sort of fishes, that is, fishes form the base of the family tree or phylum to which higher animals belong.

Form and Structure. The form of body in the normal fish is more or less cigar-shaped (fusiform), flattened from side to side so as to be elliptical in cross section. It may be divided into three parts antero-posteriorly, the head, trunk, and tail. The head contains the brain and bony box, or skull, which protects it; various sense organs as of sight (eyes), smell, and balance; the mouth and its surrounding jaws; and behind the jaws the gills. The trunk is largely occupied by a long body cavity comprising an anterior division for the heart and a posterior one for the other viscera. That portion of the body lying behind the body cavity is known as the tail. The vertebral column, a many jointed rod of bone, runs from the base of the skull, backward above the body cavity and to the end of the tail, supporting the head and body.

The body of the fish is shaped not unlike that of a submarine, and with reason, as both submarine and fish are adaptations to navigating under water, requiring the same stream-lines. We do not find in fishes the constriction between head and trunk, the neck, characteristic of most land animals. The tail of four-footed animals is homologous with that of the fish, but freed from the heavy weight of muscle which would be useless and exceedingly inconvenient to drag about on land. In normal fishes the more

or less fan-shaped caudal fin at the end of the tail, attached to the vertebral column by plates of bone, is the chief propelling organ. The entire body back of the head is covered by muscles arranged in rows of zig-zag segments along the sides and particularly thick on the tail where no space is occupied by the body cavity. These muscles propel the fish through the water. Other muscles move the jaws and control the raising and lowering of the fins, but the musculature is very simple and primitive, compared to that of land animals where complicated groups of muscles move and control the limbs.

This blanket of muscles is covered with skin, which in fishes is perhaps chiefly interesting for the armature it bears. In sharks the whole body including the head and fins is covered with a tough skin thickly studded with small points or granules which are frequently thornlike. They may be so similar to the teeth in certain sharks that it seems well-established that teeth correspond to dermal processes of this sort which have become enlarged and specialized on the jaws and inside the mouth.

Fishes next above sharks in the evolutionary scale had the head encased in a more or less bony armor and the body covered with oblique rows of close-set diamond-shaped bony scales. The gar pikes are archaic fishes of this sort still living. Thin, elastic, rounded, overlapping scales are a later development. They make an exceedingly advantageous body covering for modern fishes, combining smoothness and firmness of contour with elasticity of movement. The scales of fishes are sometimes much reduced or lacking, or their place taken by hard nodules, plates, ridges or spines. The plates and ridges may be continuous, encasing the whole body in a solid armor.

A fish's fin normally consists of a membranous web stretched over a series of jointed, more or less branched, supporting rods known as fin rays and more or less covered with skin which sometimes bears small scales. Each fin is usually strengthened by an initial unjointed spinous ray. The fins are of two kinds, vertical fins and paired fins. The vertical fins, in the plane of the fish's body, are situated along the mid line of the back (dorsal fins); around the hind end of the tail (caudal fin); and in the mid line of the under side of the tail, usually just behind the body cavity (anal fin). There are two sets of paired fins in planes more or less oblique to that of the fish's body, situated either on the ventral surface of the trunk, or in the case of the pectoral fins, often further up on the sides. These are the pectoral fins, usually just back of the head, and the ventral or pelvic fins, further back. As a rule the paired fins are movable in and out so that they may project from or lie close to the body, and incident to muscles which control such movement, fish have bones which correspond to pectoral and pelvic girdles, just as the paired fins themselves correspond to limbs of higher vertebrates.

The rays of the vertical fins are supported by small bony rods embedded in the flesh, which in turn are

in contact with processes from the vertebral column. The normal, symmetrical fan-shaped caudal fin is ventral in origin, that is, with the same relationship to the hind end of the vertebral column that the anal fin has, further forward. We can see this very clearly in the unsymmetrical caudal fin of sharks, where the vertebral column, bent somewhat upward, is traceable along the upper edge of the longer upper lobe of the fin. It is still apparent in the rayed caudal fins of such primitive fishes as sturgeon and gar pike, but in perch or bass the up turn is so shortened and obscured by symmetrical plates of bone which support this fin, as not to be traceable without dissection.

The origin of the fins seems to have been in a ridge or fold of body muscle and skin running along the mid-line of the back and around the end of the tail, and forward on the mid-line of its lower surface (vertical fins), thence divided in two, forward on the lower sides of the trunk (paired fins). Various fishes now living have continuous vertical fins occupying essentially the entire median course of such an hypothetical fold.

The fish's heart pumps the blood forward to the gills where it is aerated, and thence distributed all over the body by the anastomosing arteries, carrying oxygen to the tissues. A comparable system of veins gathers the used blood and returns that of the head to the heart directly, and that of the body to the kidneys, an irregular mass under the back bone posteriorly, where its waste products are removed. Thence, as a rule, the blood passes by way of the liver to the heart. The gills or breathing apparatus, situated in the side of the neck region are the link in this system peculiar to a fish, hence meriting more detailed consideration here. They consist mainly of very finely divided thin walled blood-vessels in fringes on the outer face of the gill arches or curved supporting rods, between which are the gill slits, not more than seven in number.

Normally water to aerate the blood in the gills through the thin walls of their component blood vessels enters the fish's mouth and is pumped out of the gill slits passing over the gills. In sharks each gill slit opens to the outside independently, but in higher fishes an opercular plate of the side of the head covers the gills and gill-slits leaving a single slit or opening for the passage of water to the outside along its hinder margin. On the concave face of each gill arch, opposite the gills there may be rod-like processes known as gill-rakers, the primary function of which is presumably to ward off extraneous particles of solid matter from the gills. In fishes which feed on small organisms in large number the gill rakers are long and make a fine meshwork for sifting such food from the water.

The swim-bladder is an organ peculiar to fishes. It may open backward from the pharynx, or be a closed bladder. It is filled with gases and lies along the roof of the body cavity. In most cases it presumably serves as a stabilizing organ, and it is frequently lacking. In the lung-fishes its walls are vas-

cular and it serves as a secondary breathing organ or lung. In the African lung-fish it is also double. This fish lives in swamps, which dry up at certain seasons, during which it aestivates curled up in a burrow in the mud, with its nose at a small opening to the outside, breathing air exclusively, by means of its double "lung."

In the majority of modern types of fishes the eggs are small and numerous, and fertilization is external. In many, like the cod, the eggs are pelagic; eggs and sperm are released to float free at the surface of the sea, where fertilization is fortuitous, though perhaps none the less certain. A single large female cod may release at one spawning some 9,000,000 eggs. In such fishes there is of course a tremendous wastage. Fish like the trout and salmon that run into fresh water and lay their eggs on spawning beds have a much smaller number of larger eggs.

As has been said the shark is an archaic type of fish which has persisted to modern times, competing successfully with more modern types of fishes. But while sharks have changed so little in body form and structures from their remote ancestors, the reproductive mechanism of sharks has in some cases become highly evolved. We may suppose that in early sharks fertilization was external, as it still is said to be in the Greenland shark. In almost all living species, however, it is internal. The ventral fins of the males have developed so-called claspers by which the sperm is transferred to the female and fertilizes the eggs in the upper portion of the oviduct. The individual eggs are few and very large with a considerable yolk mass. In the egg-laying species, after fertilization they enter a dilated portion of the oviduct where they are invested with a horny covering or shell before being deposited. In most species the embryos develop in the oviduct of the mother until the yolk has been absorbed, and are born as well-developed active young sharks. In some sharks and rays (flattened sharks) there is a further step in advance, and the unborn embryos receive nourishment direct from the mother, as for instance by complication of the inner wall of the oviduct in contact with the yolk.

Sharks are not the only fishes in which fertilization is internal and which give birth to living young. This is also true of many species of tooth-carps found in tropical America. These have the front rays of the anal fin of the male developed into an intromittent organ. They are fishes of small size abounding in sluggish fresh waters, and many of them of economic importance in mosquito control. There are also the perch-like marine surf-fishes of the Pacific coast of America.

Coloration. The colors of fishes are for the most part produced by oil sacs or pigment cells beneath the scales or in the skin. Certain colors are produced mechanically by the deflection of light due to surface structure of skin or scales. This is often the cause of certain metallic, silvery blue or iridescent colors.

There is much variation in color among different individual fishes of the same kind. In many species each individual is capable of rapid and profound color-changes. A fish's color is more or less faded or changed when it is dead, and in almost any preservative it fades so as to leave only traces behind. Hence color plays but a small part in the describing, differentiating and classifying of fishes. As a rule pattern is more persistent than actual color, or varies with age and sex.

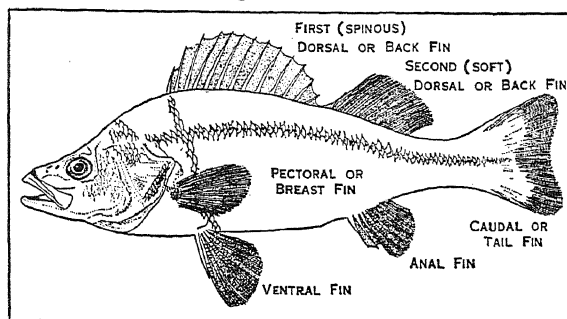
The colors of fishes are frequently brilliant, beautiful, or interesting, and show a close correlation with environment and habits of life. They predominantly tend to lower a fish's visibility. Free-swimming fishes are almost always countershaded, that is darker along the back, blending on the side into whitish lower surfaces. This is exactly the reverse of the way the shadows fall, tending to counteract them and thus obliterate the form of the body. Such fishes are bluish or greenish above, matching the blue or green water as seen from that direction, and their silvery white lower parts are equally difficult to distinguish against the light, as seen from below. Fishes that hide in weed or about rocks have a more banded and mottled pattern, frequently with colors that match that of the green, yellow or red weed where they hide. Flounders, which lie on the bottom, have white lower surfaces, and mottled, dark upper surfaces to match the bottom on which they lie. In studying experimentally the color changes of individual flounders, it was found that the pattern of mottling became coarser or finer to correspond to a coarser or finer bottom and that changes of color tone were dependent on perception of environment through the eyes.

The flounders have doubtless more than the average power of color change, but fishes of almost any species living on or near the bottom are paler when found over bright sand and darker over mud.

Low visibility is by no means the only causative factor which enters into the colors of fishes. Colors reflect the emotions of the individual fish and tend to deepen and intensify with exhilaration of one kind or another. The males of many species have definite bright nuptial colors. We find bold colors and markings which seem to be for purposes of recognition. Among the fishes which swim about tropical coral reefs, darting among and hiding in the intricacies of the reef when danger threatens, many are boldly patterned with bright colors, exceedingly conspicuous. These are known as immunity colors. The fishes are safe close to the reef, and conspicuousness is little disadvantageous to them.

Locomotion. In general the problem of locomotion is simple for a fish. The weight of its body approximates that of the water wherein it floats, and it is propelled forward by side to side motion of its caudal fin which acts at the same time as a rudder. The vertical fins tend to hold the body upright. The paired fins act as balances, and when extended serve to check forward momentum. When the fish is moving rapidly forward they are for the

most part pressed close to the body, and in fast-moving species fit into shallow depressions so as not to break the stream-lines of the same, adjusted to forward motion through the water. When, as some-



COURTESY AMER. MUS. OF NATL. HISTORY

FINS OF A TYPICAL SPINY-RAYED FISH (YELLOW PERCH)

times occurs, fast swimming fishes have a large spinous dorsal fin, this drops down into a slot in the back to be out of the way.

Theoretically the fish weaves forward through the water in a somewhat eel-like manner swimming with its whole body. In modern short-bodied forms the body is bent into but one arc at a time, curving first to one side, then to the other. In the more active species it is progressively less flexed and the motion more confined to tail region and caudal fin. The most active swimmers have the finest stream-lines and in these the caudal fin is firm and usually forked. Some of the less strong swimmers ordinarily progress by a rowing motion of the pectoral fins, using the body and caudal fin only when pressed to make greater speed, a notable example being the reef frequenting wrasses and parrot-fishes; others glide about by undulatory movements which run through the vertical fins. Various unusual fishes have methods of swimming correlated with their peculiar form and habit of life. The rays and skates are shark-like fishes flattened to lie on the bottom, wherein the pectoral fins have become fused with the sides of the body to form the wings of a flat disk. The eagle rays have secondarily become actively free swimming again, and their wings have become pointed and move up and down. They fly through the water much as does a large bird through the air.

So much for straight-away swimming. A few of the more peculiar forms of fish locomotion should also be mentioned. The flying-fishes have pectoral and sometimes ventral fins elongated and stiffened so as to make "wings" for a highly efficient glider and prolong their leaps through the air. It has been claimed that a flying-fish is also sustained or propelled by motion of these "wings," but any such effect there may be is probably negligible. The Gurnards have the anterior rays of the pectoral fins specialized as fingerlike processes whereby they crawl over the bottom. The lamprey surmounts falls by climbing vertical rock faces with its round sucking mouth. *Periophthalmus* skips about on the mud laid bare by the falling tide.

Life History. The breeding habits of the multitude of different kinds of fishes vary very greatly. As we have seen some species lay a vast number of minute eggs which drift in ocean currents left entirely to the caprice of chance. Others construct more or less simple or complicated nests where the eggs are frequently guarded by one of the parents, usually the male.

The females of certain cichlids and males of certain sea catfishes carry their eggs in their mouths until hatched, thus insuring their safety and perfect aëration by the fresh water taken into the fish's mouth, to be pumped out over its gills. In the pipe-fishes and sea horses the male carries the eggs in a pouch. In the deep-sea angler fishes (*Ceratioidea*) a remarkable state of affairs pertains. The male is very small. He seeks out and attaches himself to some part of the female at random, becoming a complete external parasite, his mouth and other organs degenerating and his vascular system becoming connected with hers.

When the small eggs, laid by most fishes, hatch, the young are usually still more or less embryonic and with a considerable external yolk sac from which they receive their nourishment for a time before beginning to move about actively and seek their own food. In most cases they then begin to assume a form and habit of life essentially though seldom quite like that of their parents. Many species of marine fishes, on the other hand have young quite unlike their parents in form and habits, that is a larval stage which lasts for a longer or shorter time. Take the case of the common eels (*Anguilla*) of fresh and shore waters, which migrate to the depths of the open ocean to spawn. Larval eels living in the upper layers of the ocean are flat, transparent, with curious long, needle-like teeth. The Gulf Stream drift carries them toward the shores of the ocean, and as the larvæ of the American and European species, respectively, approach their destination they shrink somewhat in size, assuming the cylindrical eel shape.

Fishes are less standardized in adult size than are higher vertebrate animals; some individuals grow much larger than others. In most cases, however, the period of active growth seems to be rather constant, and very large ones may be no older than others of normal size. Those inhabiting waters where there is a marked difference between summer and winter conditions grow more rapidly at one season than at another. For one who has made a study of the subject it is frequently possible to determine a fish's age and other matters pertaining to its history from the growth rings on its scales.

Many fishes undertake regular seasonal migrations wherein spawning grounds and seasons, water temperatures, and food supply are causative factors. Various species move into shallow water, upstream, or from salt into fresh water (anadromous fishes) to spawn. For contrast we have the migration of the true eels from shore or fresh waters to the depths of the ocean. Most fish migration is correlated with

seasonal changes in water temperatures, and it may take place in either of two directions, more or less north and south, following the trend of the coast or between shallow and deep water.

Classification. According to Norman (1931) probably more than 20,000 species of fishes are now recognized. This is a conservative estimate. In 1923 Jordan recognized between 600 and 700 families for the fishes of the world. Just how much diversity of kind may appropriately be grouped in one family is a matter of opinion, and many students are satisfied with a fewer number, but this will give some idea of the variety of fishes there are to be classified.

The eel-like lampreys and hagfishes have a circular, sucking mouth, without jaws, no paired fins, and are sometimes considered not to be fishes at all. Usually they are looked upon as the most primitive of fishes, with various specializations of structure peculiar to themselves and their habit of life. In view of their eel-like form and parasitic habits it is not unlikely that they are degenerate descendants of some more normal and more fish-like creature and their exact phylogenetic place in the scheme of evolution is uncertain. The hagfishes (*Myxini*) are marine, with teeth on the tongue, and small eyes. They bore into the bodies of larger fishes and remain while feeding on their tissues and they lay large eggs. The lampreys (*Petromyzonidae*) have concentric rows of teeth in the mouth, and large eyes when adult. They cling to the outside of other fishes, leaving characteristic circular scars where they have rasped off the flesh. They run into streams to spawn and lay their small eggs in circular nests of sand or gravel which they have prepared by removing larger stones with their sucking mouths.

The shark-like fishes (*Elasmobranchii*) are a very large and varied group. The family of gray sharks (*Galeidae*) is the most abundant in species and individuals, swarming in warm seas around the world. The man-eater shark (*Carcharodon carcharias*) belongs to the mackerel shark family (*Lamnidae*) and reaches a length of over 30 ft. Even small ones may be dangerous, but this shark is almost everywhere rare, and presumably only occasional individuals feed on bathers. In American waters the chance of being killed by a shark is perhaps equal to that of being struck by lightning. The skates (*Rajidae*) are sharks flattened to lie on the bottom, and the eagle rays (*Aetobatidae*) are flattened forms which have, secondarily, become free-swimming again. The electric rays (*Torpedinidae*) can give a powerful electric shock, which has a high voltage but little amperage. The chimaeras (*Chimaeridae*) are highly specialized, little shark-like, with the tail ending in a finless lash or filament.

Between the sharks and the modern bony fishes are a number of more or less unrelated primitive transitional families, archaic fishes still living, relics of the evolutionary history of fish life. Such are the lung-fishes (*Sirenoidei*), sturgeons (*Acipenseridae*), gar pikes (*Lepisosteidae*), and others. A shark's skel-

eton is mostly cartilaginous, very little of it, aside from the central or axial portion of the vertebræ (segments of the backbone), is hard, compact bone. These other archaic fishes are relatively much bonier, though less completely bony than modern forms.

The most primitive and probably the earliest important group of modern fishes (*Teleostei*) to appear in geologic time was the soft rayed fishes (*Isospondyli*), to which the herrings (*Clupeidæ*), trout (*Salmonidæ*), and other families belong. The herrings are for the most part small silvery fishes with one fin in the middle of the back, swimming in schools, and feeding on small organisms which, to a greater or less degree, they sift from the water with the aid of their long, fine, gill-rakers. The gill-rakers of one of the herrings, the menhaden (*Brevoortia tyrannus*), for instance, make so fine a sieve that it can actually gather as a principal food supply the microscopic floating plants known as diatoms. Animal life is directly or indirectly dependent on plant life for nourishment, hence it follows that these diatoms are a principal basic food supply of the ocean, eaten by minute animals which in turn are eaten by larger ones that are on the fish's bill-of-fare.

Various of the early modern fishes, among them the trouts, have a second small ray-less so-called adipose fin on the back near the tail. Catfishes and characins also have such a fin. Its purpose or history is unknown. Certainly more recent than the *Isospondyli* are the *Ostariophysi* of which the principal families are the carps (*Cyprinidæ*), characins (*Characinidæ*), and catfishes (*Siluridæ*). The *Ostariophysi* seem always to have been a fresh-water group. They dominate continental fresh-water fish faunas, and are absent except by chance from insular ones, and that of the Australian region. The eels are a large and varied group of doubtful relationships, probably in part at least descended from the *Isospondyli*.

Contrasted with these soft rayed fishes we have the truly modern spiny rayed fishes (*Acanthopterygii*), wherein a varying number of anterior rays of dorsal and anal fins are characteristically simple, pointed, unjointed spines. Frequently the spiny and soft parts of the dorsal fin are partially or completely separated into two fins. The transformation of fin rays to spines is by no means confined to this modern group. There may even be spines in the fins of sharks; the spined dogfish (*Squalus acanthias*) being a familiar example. The extent to which spiny rays are developed is, however, characteristic of the *Acanthopterygii*, to which almost half of the families of fishes as listed by Jordan belong. Typical families of this group are the perches (*Percidæ*), sea-basses (*Serranidæ*), croakers (*Sciaenidæ*) and butterfly-fishes (*Chaetodontidæ*).

A derivative, active free-swimming series embraces such families as the crevallys (*Carangidæ*) and mackerels (*Scombridæ*); a particularly spiny bottom inhabiting series, such families as sculpins (*Cottidæ*); and a sluggish series, such families as the trigger fishes (*Balistidæ*), file-fishes (*Monacanthidæ*), box-

fishes (*Ostraciidæ*) with the body almost completely incased in a bony shell or box, swell-fishes (*Tetraodontidæ*), and big ocean sunfish (*Molidæ*). The gobies (*Gobiidæ*), blennies (*Blenniidæ*) and anglers (*Lophiidæ*) are families from other specialized series of this group.

Between the soft rayed fishes mentioned first and these latter with spiny-rayed affinities, there are at least two series of more or less transitional families, the first containing the pikes (*Esocidæ*), top minnows (*Pæciliidæ*), and others, the other the needle-fishes (*Belonidæ*), halfbeaks (*Hemiramphidæ*), flying-fishes (*Exocoetidæ*). Authors differ as to whether they place here the series containing the soft-finned cods (*Gadidæ*) and so forth, and that of the asymmetrical flatfishes which lie on one side on the bottom (*Heterasomata*), or consider them as specializations of some Acanthopterygian group. The same is true of the specialized pipe-fishes (*Syngnathidæ*) of which the little sea horse is a member, perhaps the most un-fishlike of all true fishes, swimming upright in the water, its head at right angles to its body, with a constricted neck region, and a slender, finless, prehensile tail.

Distribution. The three main divergent habitats for fishes are marine shore waters, fresh waters, and the deep sea.

Shore waters are the center of abundance of fish life where competition is keenest and evolution has been most rapid. They are dominated by up-to-date types of fishes. Here numerous related species of the large modern families abound side by side. The shore fishes extend down to depths of around 50 fathoms or more, and fishes found at the surface of the high seas belong with the shore fishes rather than with those of the depths.

From about 50 fathoms, where as a rule the continental shelf rounds off into deep water, conditions change very rapidly as one goes deeper; except in high latitudes the water becomes colder, and sunlight becomes fainter. Presently one reaches the abyss beyond the penetration of light from above. The deep-sea fishes which inhabit this lower world are less standardized than those of shore waters and unlike them. They are for the most part highly specialized, in correlation with their peculiar conditions of life. Many of them produce phosphorescent light, occasionally from the entire skin, but usually localized in definite phosphorescent organs or photophores. Deep-sea fishes may be obviously specialized derivatives of modern shore groups. Take for example the deep-sea anglers, which sometimes have luminous baits on the peculiar rodlike structures above their snouts. They may be more primitive, representatives doubtless of faunas which flourished in shore waters in past time. Down to the limit of light penetration they have large eyes. Beyond that the eyes are either very large to take full advantage of stray phosphorescent gleams, or practically lacking like those of blind cave fishes, or of a mole. They sometimes have tremendously large mouths and distensible stomachs and

are capable of swallowing other fishes larger than themselves.

Whereas the characteristic fishes of the surface of the open ocean, such as the flying-fishes (*Exocoetidae*), off-shore mackerels (*Scombridae*), and so forth, belong with the shore fauna, there are others which rise toward or to the surface at night from the middle waters, which belong with the deep-sea fauna. Such are the little, silvery lantern-fishes (*Myctophidae* or *Scopelidae*), which have a row of small, round phosphorescent organs on their lower sides, suggesting the portholes of a ship, and capable of emitting a luminous glow.

The fishes of fresh waters are less different from shore fishes than are those of the deep sea, yet in many cases are less clearly related to them, belonging to groups which seem never to have been marine. They present less variety than do shore fishes, have less competition to face and tend to be more primitive. It is in fresh water that one finds transitional forms, once abundant, and now all but gone, persisting only here and there, such as the sturgeon, the gar pike, the lungfish.

There are then three main fish faunas of the world, (I) Fresh-water Fishes, (II) Shore Fishes, (III) Deep-sea Fishes.

Economic Importance. The principal importance of fish to man is as a staple article of food. Between 300,000,000 and 400,000,000 cod are believed to be caught annually in the Atlantic; the herring fishery is probably more important than the cod fishery; and the total value of the catch of all fishes throughout the world may be in the neighborhood of \$1,000,000,000. The value of fresh-water fisheries is negligible as compared with sea fisheries. Fisheries of the Great Lakes are, however, of considerable importance. Fishes which grow in the sea and are taken when they run into fresh water to spawn add materially to the world's food supply. For instance the pack of canned salmon goes all over the world, and locally the shad is much esteemed as a table delicacy.

The greatest variety of fish life and of marketable marine fishes occurs on tropical shores. The greatest abundance of fish, pound for pound, however, is probably in cold-temperate waters. One reason for this is that in cold water the wastage of organic matter from bacterial action is slower, and hence the food supply of marine life maintains itself better. The principal fisheries of the world lie for the most part between the latitudes of 40° and 70° N. The fisheries of Great Britain, France, Spain, Norway, Russia, Canada, the United States and Japan together are said to represent 70% or more of the total yield of the fisheries of the world. There are great areas of shallow sea in this part of the world where marketable fishes abound and are readily caught.

It is remarkable that with the very great amount of fish taken year after year by man the supply has not been more seriously depleted than seems to be the case. Such is the vast number of existing indi-

viduals, the wide range, the productivity, and dependence on natural environmental forces and conditions, in those species essentially pelagic through life, that their numbers are little affected. The number of cod in the world seems to fluctuate according to which years are favorable for survival of cod-fry. The annual catch of mackerel seems to fluctuate with the amount of sunlight, affecting the multiplication of diatoms, and of crustacea and so forth eaten by the mackerel and for which the diatoms are a basic food supply. In fishes restricted to shore waters, in those species which ascend rivers to spawn, in the fishes of ponds and streams, we have another story.

Fortunately, enough is known of the breeding habits of many species so that they can be propagated artificially, and this is particularly true of fresh-water fishes. The supply of bass and trout is now as subject to human control as that of domestic animals. In anadromous fishes like the shad and salmon it is possible to take and hatch the eggs eliminating the natural wastage in the egg stage, and theoretically maintaining the supply with a relatively small number of brood fish. The ease with which the natural development of fish eggs can be retarded by storing them with ice makes it possible to introduce certain species into far distant waters, as, for instance, trout in the Southern Hemisphere. Fisheries conservation in general is dependent only on knowledge, intimate knowledge of the fish's life history, and of the balance of life in the waters, and much significant research on the subject is going forward, local, national, and international.

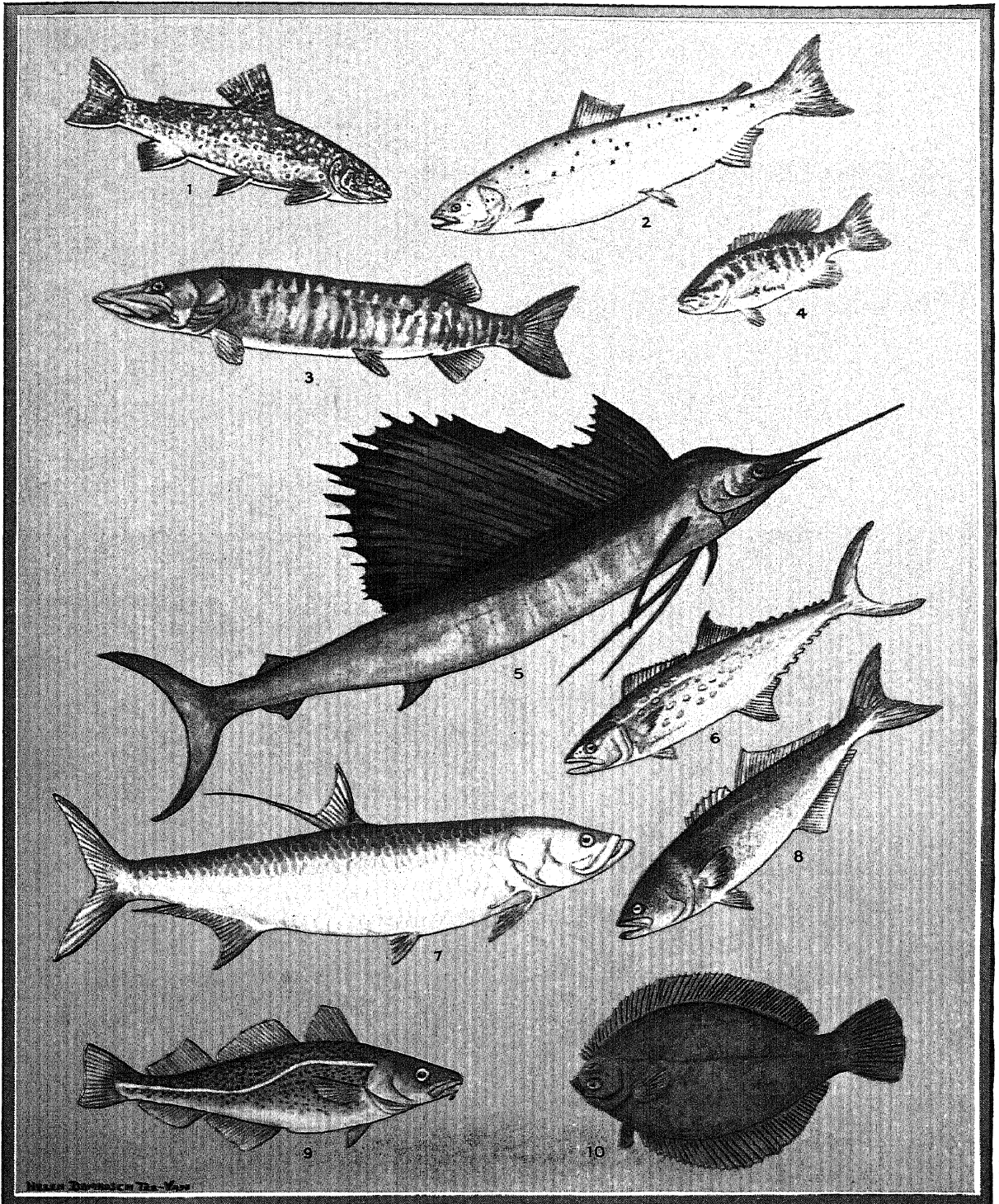
Whereas fish are chiefly important as food, they yield a variety of other commercial products, among which may be mentioned oil, fertilizer, glue, leather. Then again the human race would be spiritually impoverished without the pastime of angling, a relaxation, a sport, an art, or call it what you will. And an increasing number of persons obtain pleasure and interest, æsthetic or scientific, from keeping fishes in small home aquaria. J. T. N.

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FISHING TACKLE, the equipment used in the sport of angling. This consists of the rod, line, hooks, reel, flies, nets and other fishing paraphernalia, now produced in great variety.

The ingenuity in the design of modern fishing tackle largely explains the increase in the number of enthusiasts during the present century. The rod for fresh-water fishing is made solid or in built-up sections. In the former class, the most desirable woods are greenheart and lancewood. The built-up rods are

FISHES

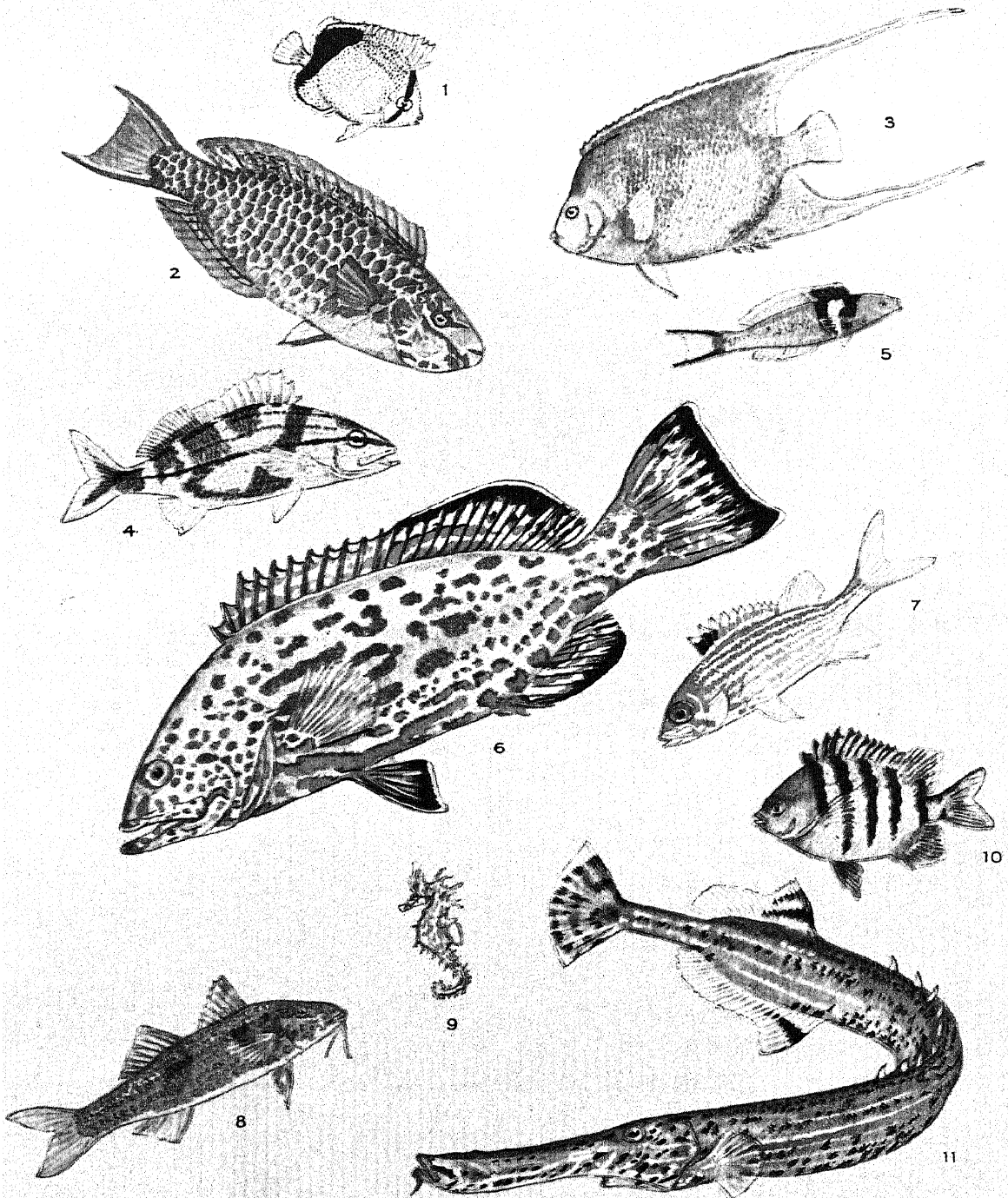


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AMERICAN FOOD AND GAME FISHES

1. Brook Trout (*Salvelinus fontinalis*).
2. Atlantic Salmon (*Salmo salar*).
3. Muskellunge (*Esox masquippony*).
4. Small-Mouthed Black Bass (*Micropterus dolomieu*).
5. Pacific Mexican Sailfish (*Istiophorus greyi*).
6. Spanish Mackerel (*Scomberomorus maculatus*).
7. Tarpon (*Tarpon atlanticus*).
8. Bluefish (*Pomatomus saltatrix*).
9. Cod (*Gadus callarias*).
10. Winter Flounder (*Pseudopleuronectes americanus*).

FISHES



Illustrations by Helen Damrosch Tee-Van

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TROPICAL FISHES

Butterfly Fish (*Chaetodon sedentarius*).

Parrot Fish (*Scarus vetula*).

Angel-Fish (*Angelichthys isabelita*).

Surge wrasse (*Thalassoma melanurum*).

Surge wrasse or Bluehead (*Thalassoma bifasciatum*).

6. Yellow-Finned Grouper (*Mycteroperca venenosa*).

7. Squirrel Fish (*Holocentrus tortugae*).

8. Red Goatfish (*Upeneus maculatus*).

9. Sea Horse (*Hippocampus punctulatus*).

10. Sergeant Major (*Abudefduf marginatus*).

11. Trumpet Fish (*Aulostomus maculatus*).

made of the outside siliceous layers of the bamboo tree; six or eight layers are glued together to form a hexagonal or octagonal shaped rod. The fly-fishing rod should be between 9 and 10 feet in length, weighing about 6 ounces. For bait casting, rods may be 6 feet long and weigh 7 ounces. The line most favored by experienced fishermen is made of enameled, waterproofed silk. The level line has the same diameter throughout its length. The tapered model is thicker in the middle length of the line, and is used for long casts. The reel is made in great variety, with single or multiple action. A common model in the first class is the light, narrow spool of metal, attached to the butt of the rod, capable of carrying 30 yards wound on the spool. The automatic reel, another model, winds the line when a spring is released. Hooks come in many designs. The straight, spoon and eye hooks are familiar models; but the angler must let experience decide the most efficient in his waters. The artificial fly comes in two classes, the wet-fly, which sinks below the surface of the water, and the dry-fly remaining on the surface.

FISH LADDERS, or fishways, devices by which fish seeking upriver spawning grounds are enabled to surmount waterfalls, dams or other obstructions. The principle of a fishway is to retard the current or break the height of a waterfall. There are four types: 1. The incline plane; 2. The pool and fall or step system, which breaks one waterfall into several, with comparatively quiet pools between; 3. The counter current, in which descending water is checked by meeting an opposing current at intervals; 4. The lock and gate system. All fish ladders should be where the fish naturally pass, in abundant water free from human disturbance, and as far as possible self-purifying and kept free of debris. Tops and sides should be above ordinary high water, and the outlet below the low level. In the United States, the improved Cail fishway, largely designed by H. von Bayer of the U.S. Bureau of Fisheries, is generally endorsed. This is a combination of the incline plane with the pool and fall system, and is adaptable to local conditions, including the type and size of fish, water flow and available material for construction. Fishways for young eels are merely inclined pipes or narrow flumes with brush fascines.

FISH MEAL, the product obtained by processing and grinding fish, fish residues, or shell fish, usually after the oil is extracted. Fish meal may consist largely of the entire fish, as menhaden herring, or the part remaining after the removal of the larger muscles for human food. The meal is rich in protein (see PROTEIN IN FOODS) and is used largely as a supplement to grain in the rations of hogs and poultry. Feeding experiments show it to compare favorably with tankage as a feed for livestock. A good grade of fish meal contains 50% or more of protein. The product can be safely stored, undergoing but little deterioration, and is convenient for use in self-feeders and dry-mash hoppers. A bushel of fish meal weighs about 35 lbs. J. R. M.

FISH-MOTH, a very primitive insect of the order *Thysanura*, also known as the silver-fish. The body is covered with scales, hence the popular names. The adults, like the nymphs, are wingless. They have long antennæ and three thread-like processes at the tip of the abdomen. They often damage books, wall paper, laundry, or other objects on which starch or glue is used. Pyrethrum powder dusted abundantly in places where fish-moths hide, or poisoned paste, will exterminate them.

FISH PASTES. See PASTES, ALIMENTARY.

FISK, JAMES (1834-72), American capitalist and speculator, was born at Bennington, Vt., Apr. 1, 1834. During the Civil War he made some wealth for himself from deals with the Government, afterward opening an unsuccessful brokerage office in New York City, where, with Daniel Drew, he had joined the fight for control of the Erie Railroad. The Drew-Fisk forces, combined with the Gould-Eldridge interests, forced out Cornelius Vanderbilt, and Fisk became vice-president of the railroad. He and Gould started a campaign to corner the gold market. This netted them large sums, but their manipulations led to the disaster of "Black Friday," Sept. 24, 1869. Fisk was killed by E. S. Stokes, a dissolute business associate, at New York City, Jan. 7, 1872.

FISKE, JOHN (1842-1901), American philosopher and historian, was born at Hartford, Conn., Mar. 30, 1842. He was educated at Harvard and at Harvard Law School, but did not practise law. In 1869 he lectured on philosophy at Harvard and in 1870 was appointed to the history faculty at the same university. In 1884 he became professor of history at Washington University. His works comprise volumes on both philosophy and history. In 1874 he published *Outlines of Cosmic Philosophy*, which did much to popularize the theory of evolution. *The Idea of God as Affected by Modern Knowledge*, published in 1885, and *The Origin of Evil*, 1899, may be said to sum up Fiske's attitude toward religious and philosophical problems. In the field of history his *Historical Works*, in eleven volumes, form an almost complete history of the United States from the time of the discovery of America to the establishment of the Federal government. Fiske died at Gloucester, Mass., July 4, 1901.

FISKE, MINNIE MADDERN (1865-1932), American actress, was born at New Orleans, La., Dec. 19, 1865. At the age of three she appeared in a production of *Richard III* (as the infant Duke of York) and at 15 was a star. Her first New York appearance was in 1870, in *Fritz, Our German Cousin*. She played Prince Arthur to John E. McCullough's *King John* in 1874, and was also in productions with Barry Sullivan and Edward L. Davenport. She left the stage after her marriage in 1890 but four years later returned to the theater in *Hester Crewe*, also playing in *A Doll's House*. Her Ibsen performances were her most celebrated rôles, but she appeared with considerable success also in *Tess of the d'Urbervilles*, 1897, *Leah Kleschna*, 1904, and *The New York Idea*, 1906. Later

plays were *Mrs. Bumpstead-Leigh*, and, in 1930, *The Rivals*. She was also the author of the plays *A Rose, A Light from St. Agnes, The Eyes of the Heart, Not Guilty*, and she collaborated in *Fontenelle*. Mrs. Fiske's last engagement was in *Against the Wind*, 1931. She died at Hollis, Queens, New York City, Feb. 15, 1932.

FISK UNIVERSITY, at Nashville, Tenn., a co-educational institution for Negroes, was founded in 1865 through the efforts of the American Missionary Association of New York and the Western Freedman's Aid Commission of Cincinnati. It was named in honor of Gen. Clinton B. Fisk. The university comprises preparatory, collegiate, normal and industrial departments, and a summer school. The students assist in the care of the buildings and grounds. Fisk University has an endowment of \$1,206,968, and the library contains 21,000 volumes. In 1930 there were 504 students enrolled and a faculty of 46, headed by Pres. Thomas Elsa Jones.

FITCH, JOHN (1743-98), American inventor, was born at East Windsor, Conn., Jan. 21, 1743. At the age of 17 he went to sea, and on his return to the colonies became a clockmaker, and later a brassfounder and silversmith. During the Revolution he was a gunsmith, and wintered with Washington's troops at Valley Forge. After a series of trading tours to the West, where for a brief time he was held prisoner by the Indians, Fitch settled at Warminster, Pa., and in 1785 he built a steamship model. The following year he constructed a 45-foot vessel, in which he laid a 12-in. cylinder engine, and on Aug. 22, 1787, made a successful demonstration on the Delaware. He was unable to find support, and was refused aid by the state legislatures to whom he applied. In France his efforts to introduce his steam-vessel were blocked by the Revolution. Although Fulton is generally credited with the invention, Fitch's crude vessel antedated the *Clermont* by fully 20 years. In a fit of discouragement, Fitch committed suicide at Bardstown, Ky., July 2, 1798.

FITCH, SIR JOSHUA GIRLING (1824-1903), English educator, was born in London, Feb. 13, 1824. He graduated in 1850 at the University of London and became associated with the Borough Road Training College of which he was principal from 1856-63. From 1863-1894 he was prominent in the department of school inspection in England and Wales, and published *Lectures on Teaching*, 1881; *Educational Aims and Methods*, 1887, and *Thomas and Matthew Arnold*, 1901. He died in London, July 14, 1903.

FITCH, WILLIAM CLYDE (1865-1909), American playwright, was born at Elmira, N.Y., May 2, 1865. His first success, *Beau Brummell*, was produced in New York City in 1890, and was played by RICHARD MANSFIELD for nearly 1,000 performances. His other plays include *Lovers Lane*, 1901, *Nathan Hale*, *Barbara Frietchie*, *Captain Jinks of the Horse Marines*, *The Climbers*, *The Stubbornness of Geraldine*, *The Girl with the Green Eyes*, *Her Own Way*, *The Woman in the Case*, *The Truth* and *The City*,

1909. Fitch has been described as the light comedian of American playwrights. He died at Châlons-sur-Marne, France, Sept. 4, 1909.

FITCHBURG, a city in northern Massachusetts, one of the county seats of Worcester Co., situated on a branch of the Nashua River, 48 mi. northwest of Boston. It is served by the New Haven and the Boston and Maine railroads. There is an airport. A century old industrial center, Fitchburg has more than 100 manufacturing establishments. In 1929 the total factory output was valued approximately at \$43,000,000; the retail trade reached the sum of \$18,980,093. Paper leads in production, followed by foundry and machine products, woolens and worsteds, saws, firearms, bicycles and other articles. A State Normal School is located here. Several lakes and hills are near by. Fitchburg was settled in 1719. Named after John Fitch, it was incorporated as a town in 1764, becoming a city in 1872. Pop. 1920, 41,029; 1930, 40,692.

FITS AND TOLERANCES, terms used to denote the degrees of accuracy with which parts are fitted together. Modern machines and methods enable working within a tenth of a thousandth of an inch or less, but this cannot always be exactly duplicated. Hence, we determine how much of a variation we can "tolerate" and fix this as the tolerance for the part in question.

The kind of fit, or the dimensions of the mating parts, depend on their intended use. On the BEARING of the crankshaft in an automobile engine, an allowance must be made of from one to two thousandths of an inch space or clearance between the shaft and the bearing to permit the lubricating oil to keep the surfaces apart. This clearance is the *fit* but it must not be confused with the *tolerance*, which is the amount of variation that can be tolerated from this standard.

If the desired clearance is 0.0015 in. and if the work cannot be done to a less tolerance than 0.0005 in., it is not likely that the desired clearance will be obtained very often unless we resort to selective assembly. (See PRODUCTION, INTERCHANGEABLE.) For with the shaft 0.0005 large and the bearing 0.0005 small the clearance would be only 0.0005 in.; with a small shaft and a large bearing the clearance would be 0.0025 in. Few shafts and bearings would go to the extreme limit in either direction, but this would be possible. By selecting large shafts to go with large bearings and vice versa the desired clearance can be maintained fairly easily.

Confusion sometimes arises from using the term tolerance and *limit* interchangeably. As generally understood, limit refers to the full or limiting dimensions as 2.155-2.160 in. This means that the smallest permissible dimension is 2.155 and the largest is 2.160 in. The tolerance is the difference between the two dimensions, or 0.0005 in.

Fits vary with the kind of machine in which the part is used. Tolerance varies with the accuracy required or the variation that can be tolerated. While

in most cases parts go together with more or less clearance there are many parts which must be forced together to insure against their coming loose. These may be either press fits or shrink fits. In either case the piece entering the hole must be larger than the hole itself. In a press fit the forcing of the piece into the hole must stretch it sufficiently to allow it to enter but must not stretch it beyond the elastic limit of the metal. In shrink fits the outer piece is expanded by heat sufficiently to allow the inner piece to enter. The cooling shrinks it in place. In some cases shrink fits are made by cooling the entering part with dry ice or liquid air, but this is not common practice. In any fit, care must be taken not to allow too much difference between the parts or the fit will not hold.

F. H. C.

FITTIG, RUDOLF (1835-1910), German chemist was born at Hamburg, Dec. 6, 1835. He devoted his attention to problems relating to unsaturated acids and to general organic chemistry. In his studies of the hydrocarbons he discovered the phenanthrens fluoranthens and lactones. He died at Strasbourg, Nov. 19, 1910.

FITTIG'S SYNTHESIS, the preparation of compounds similar to ethyl benzene ($C_6H_5C_2H_5$) by the action of metallic Sodium on a mixture of ethyl bromide (an alkyl halide) and bromobenzene (an aromatic halide). It is similar to the reaction used by Wurtz for the preparation of aliphatic hydrocarbons by the action of metallic sodium, Zinc or Silver on alkyl halides. By the application of this synthesis, it is possible to prepare toluene, ethyl benzene and related compounds; biphenyl, etc. The reaction is sometimes modified by carrying it out in the presence of a diluent such as ether. See ETHYL COMPOUNDS.

L. C. A.

FITZGERALD, EDWARD (1809-83), English author and translator, was born at Woodbridge, Suffolk, Mar. 31, 1809. He was educated at Trinity College, Cambridge, and after living in Paris, settled down at Woodbridge to a life of quiet retirement. Although Fitzgerald wrote several books and made a number of translations from Greek and Spanish dramas, his fame chiefly rests on his translation of *The Rubaiyat of Omar Khayyam*. He had difficulty getting this published, but it was finally brought out in 1859 in pamphlet form. It attracted no attention and was about to pass into oblivion when it was discovered and praised by A. C. SWINBURNE and D. G. ROSSETTI. Nine years passed before a second edition was necessary, and then the book slowly became a success. It has been published in many English and American editions and hundreds of thousands of copies have been sold. Fitzgerald died at Merton, Norfolk, June 14, 1883.

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FITZGERALD, GEORGE FRANCIS (1851-1901), Irish physicist, was born at Dublin, Aug. 3, 1851. In 1877 he became a fellow of Trinity College, Dublin, and began a series of researches relating

to problems of light and magnetism. He had a profound influence upon HEINRICH HERTZ. The MICHELSON-MORLEY experiment of 1881-87 interested him in working out the formula for the correction governing the change in shape of a body caused by its motion. He died at Dublin, Feb. 21, 1901.

FITZGERALD, a city and the county seat of Ben Hill Co. in southern Georgia, situated about 100 mi. southeast of Macon. Bus and truck lines and two railroads serve the city. Cotton, tobacco, peanuts and truck garden products are the chief crops; cotton goods manufacture is the principal industry. Jefferson Davis was captured 9 mi. from here. Fitzgerald was incorporated in 1895. Pop. 1920, 6,870; 1930, 6,412.

FITZMAURICE-KELLY, JAMES (1857-1923), English writer, was born in Glasgow, June 20, 1857. From his youth up, all his energies were concentrated on the study of the Spanish language and literature. Educated at Oxford, he was appointed professor of these two subjects at Liverpool University, 1909, and London University, 1916. He delivered many courses of lectures at American Universities. His services to Spanish literature were recognized by honours from the Spanish and Portuguese Academies, who considered his *History of Spanish Literature* a masterpiece. He edited many editions of Spanish authors, including CERVANTES, until his death, at Sydenham, Nov. 30, 1923.

FIUME, a city of northern Italy, capital of the province of the same name, on the Fiumara (Serbo-Croatian *Recina*) River, where it flows into the Adriatic and forms the Yugoslav frontier. The chief points of interest in the narrow, congested old city are the cathedral and St. Vitus Church. The new city has grown toward the west along the sea with wide streets and dignified buildings, fine parks, a large harbor and industrial plants. Although the city no longer retains the importance it had as sole port of the old Hungary, it has made progress since the World War and is now the third largest Italian port on the Adriatic. An old Roman fortress, it came into the possession of the Frankish realm. First mentioned as Vinodol in 1260, it had several overlords before it became Austrian and later Hungarian. After the break-up of the Austro-Hungarian monarchy, a bitter struggle ensued between Italy and Yugoslavia for the possession of the city. The inhabitants declared for union with Italy in 1918, while the Paris conference favored Yugoslavia. GABRIELE D'ANNUNZIO seized the city in 1919, but was ejected by troops of the Italian government the following year, and in 1924, after a series of negotiations with Yugoslavia, the city, with its harbor, was recognized as Italian territory; the neighboring Porto Barros was ceded to Yugoslavia. Pop. 1931, 52,928.

FIVE FORKS, BATTLE OF, Apr. 1, 1865, an engagement of the CIVIL WAR which resulted in the decisive Union victory of the war. Beginning the final drive against the Confederate army of 50,000 under Gen. Lee, Gen. Grant, commanding the Union

army of 100,000, gave Gen. Sheridan free leave to attack the extreme right of the Confederate line, at Five Forks, Va., an important junction point. The position was held by Gen. Pickett with five brigades; Lee had massed the greater part of his army in the immediate vicinity, anticipating an attack. Sheridan carried the Confederate lines on Apr. 1. Pickett's troops abandoned the field in complete rout; nearly 6,000 prisoners were taken. In the day's fighting the Union force lost fewer than 1,000 of its 25,000 actively engaged. This defeat brought about the disintegration of the entire Confederate army.

FIVE HUNDRED, a card game for three or four players. The pack includes a joker, but uses only cards above the six-spot when three play. A four-handed, partnership, game involves all cards above the three-spot, except the fours of diamonds and hearts. Each player receives 10 cards in rounds of threes and twos. The remainder, forming the widow, are left face downward. Bids of six, seven, eight, and nine tricks may be declared in the four possible trump suits, or in no-trumps. The suits are valued for a bid of six as follows: clubs 40, spades 60, diamonds 80, hearts 100, and no-trumps 120. In mounting bids, this value is multiplied by two for a bid of seven, three for a bid of eight, etc.

The highest bidder takes the widow and discards three from his hand before he leads. If trumps are declared, the highest card is the joker; next comes the Jack, called the right-bower, and then the Jack of the same color, called the left-bower. Other cards follow in order with ace high. In a no-trump hand, the joker is the only trump, and may be used when a player can no longer follow suit. The ace is the next highest card. The joker may be led with a call for any suit. A bidder scores only the bid. If he does not fulfill his contract, he is set for the corresponding amount, and his opponents score 10 for each trick. The first to make 500 points wins, a bidder having first chance.

FIVE NATIONS, or the Five Civilized tribes, a collective name applied to the Cherokee, Chickasaw, Choctaw, Creek and Seminole Indian tribes now living in Oklahoma, given them because of the abandonment of their own culture and adoption of the white man's life and customs. They were not confined to reservations but were granted lands by patent with certain restrictions.

FIVE-POWER NAVAL TREATY, an agreement devised at the WASHINGTON CONFERENCE, signed Feb. 1, 1922, by plenipotentiaries of the United States, Great Britain, Japan, France and Italy, for the limitation of naval armaments. The treaty was not in full force until the belated ratifications of Italy, Feb. 16, 1923, and France, July 11, 1923; under the French ratification the Government committed itself only for a period of 10 years. The treaty itself provided for termination two years after one of the contracting Powers should give notice of closure, no such notice to be acceptable before Dec. 31, 1934; and for conditional suspension of obligation during a period of hostilities involving any one of the signatories.

The treaty provided for the immediate abandonment of all national programs for the building of CAPITAL SHIPS, and for construction of no vessels of that type except as specifically sanctioned in a detailed schedule for the replacement of obsolescent ships. The schedule, extending to 1942, permitted the building of a total standard DISPLACEMENT TONNAGE of, for the United States, 525,000 tons; Great Britain, 525,000 tons; Japan, 315,000 tons (hence the popular expression of the ratio as "5-5-3"); France and Italy, 175,000 each. The total displacement of AIRCRAFT CARRIERS of the United States was limited to 135,000 tons; Great Britain, 135,000 tons; Japan, 81,000 tons; France and Italy, 60,000 tons each. Aircraft carriers might be replaced after 20 years' service. No retained capital ships or aircraft carriers might be reconstructed except to provide defense against air or submarine attack; equipment for such defense was not to increase the displacement of any ship more than 3,000 tons. Other provisions related to the scrapping of vessels, certain fortifications and naval bases, and otherwise provided for the limitation of armament.

FIVE-YEAR PLAN (Russian *Piatiletka*), a comprehensive scheme for the development of the Union of Soviet Socialist Republics during the period beginning Oct. 1, 1928, and ending, due to a three-months' extension, on Dec. 31, 1933. Its primary object has been to effect a rapid rise in the material and cultural level of the country by increasing production. Plans for both agriculture and industry have been worked out in detail, as well as a financial budget and a program of exports and imports. Books, amusements, workers' clubs and vacation resorts have been included in addition to the more material needs. It is spectacular because Russia has hitherto been one of the most backward countries in Europe in respect to industrial production. Such a program is possible only in a socialistic state, where the motive of private profit has been eliminated and individual initiative works only in the channels provided by state planning.

Because Russia requires a larger amount of raw materials and more machinery if production is to keep pace with the growing demand for goods, special attention has been devoted to new construction. The plan includes the development of the Kuznetz Basin and the Ural region as basic sources for coal and metals. It is estimated that the new Magnitogorsk works alone will produce 4,000,000 metric tons of pig iron annually. At Stalingrad and Nizhni Novgorod are tractor and automobile works on a large scale. In the Caucasian region are large hydroelectric stations, oil pipelines and non-ferrous metal works. According to the Five-Year Plan the output of electrical power was to be quadrupled in the five years, providing even the villages with current, while the output of coal and oil was to be doubled. In the revised plan, these schedules have been raised.

Although emphasis has been laid on the heavy industries during the first years of the plan, the ultimate aim has been an increase in CONSUMERS' GOODS,

and considerable progress has also been made in the development of the light industries. New cotton, linen and sugar factories have been built, and the production of textiles, leather goods and common household articles has been on the increase.

The agricultural program is closely related to the industrial, depending upon it for its mechanical equipment, and providing food supplies for its own and industrial workers. The plans for collectivization has aimed to replace the medieval system of strip farming, under which part of the land lay fallow each year, with modern large-scale methods depending upon machinery. That is why the tractor plays so important a part in the Five-Year Plan. Large state farms numbering several thousand have been organized on hitherto unused land, and serve as models and experiment stations. Hundreds of thousands of collective farms have been organized by encouraging the peasants to pool their small land holdings together with their machinery, equipment and cattle. Houses, gardens, domestic animals and personal belongings are not collectivized. Special attention has been paid to the problem of specialization in agriculture. Each district is studied by experts to determine the products for which it is best fitted, in view of its climate and its distance from the centers of population. Among the technical problems studied in order to increase the productivity of agriculture are means of combating drought, the distribution of improved strains of seeds and the most effective use of fertilizers.

The agricultural as well as the industrial worker has benefited from the higher standard of living, the increased amount of many commodities available, the opportunities for education, and the lowered death rate. Partly due to a realization of these facts, partly due to social pressure from their fellows, there was a rapid movement of the peasants into collectives during the latter part of 1929 and the spring of 1930, accomplishing in a few months more than had been planned for the whole five years. The collectivization movement spread even more rapidly in the fall of 1930 and spring of 1931, and by May 1931 embraced over 50% of the total number of peasant households.

The carrying out of so radical a program has met with many difficulties. The necessity of adding to the industrial population many workers without training or experience in running machinery has resulted in costly mistakes and a large proportion of breakages. The shortage of skilled labor and qualified technical experts has been met in part by calling in foreign workers and engineers, in part by enlarging the technical schools, and giving shorter but more intensive courses. Personnel work is being developed for the purpose of suiting the worker with a job which he will not be tempted to leave, and workers are also urged to stay at their jobs as a patriotic sacrifice.

Allocation of the national income among all the various activities of the state is accomplished by a unified budget, and the actual distribution of funds

is accomplished largely through the state banks. Each industry has its allotted income as a deposit in the bank against which it can draw checks or currency in payment of wages and other expenses. The financing of industry by the discounting of commercial bills has therefore ceased in Russia. Closely related to the problem of domestic credit is that of obtaining foreign credit to pay for imports into Russia. For the purpose of building up credit balances abroad the government has taken products with a ready foreign market—especially wheat, furs, oil and timber—and from their sale paid for the agricultural and industrial machinery and other goods essential to the success of the Plan.

The Five-Year Plan has many points of resemblance to the rationalization program for industry being advocated in other parts of Europe. The continuous working week, under which the factory works continuously but each individual has one day off in five and the seven-hour day, the increase in the number of working shifts, and the utilization of the plant to its full capacity might fit into either plan. But the Five-Year Plan is more effective than rationalization because it has a wider scope and includes all industries in one program. The Five-Year Plan is only the first step in the economic reconstruction of the country. Already the State Planning Commission (*Gosplan*) is working out a second five-year plan to cover the period 1933-37, in order to continue the process of industrialization and raise the standard of living to a new high level. The concentration of popular attention on the first five years was a valuable aid in attaining the desired tempo. M. G. M.

FIXATION, the process of holding or making permanent; a stopping point in the development of the libido. The first meaning indicates the older usage of the term in psychology, the second its newer meaning in psychoanalysis. By the fixation of attention is meant the bringing of an object or an idea to the focal point where it can best be viewed for the purpose in question. When the object is thus held before attention it is customary to refer to attention as being fixated on the object. The fixation of habit refers to the process by which the arcs of habit are built up. It is what is involved neurologically in the process of habit formation.

In psychoanalysis the term fixation has a meaning of its own. Here it refers to an arrested development of the libido. In its normal development the libido must outgrow certain infantile stages. When it fails to do this and clings to its early objects, fixation takes place. The libido passes from its infantile through its latent and adolescent stages to maturity. Fixation may take place at any of these points. It represents a reversion to, or perhaps better, a hangover from one of its earlier stages. One of the most common types of fixation is that in which the child clings to its mother and develops a special dependence on her. This is known as mother-fixation. In its extreme form it may develop into an Oedipus complex. Fixation is very apt to cause some kind of a complex.

FIXATION OF NITROGEN. *See* NITROGEN FIXATION.

FIXED ASSETS, possessions either tangible or intangible. Examples of tangible are land, buildings, equipment, tools and machinery; of intangible are goodwill, patents, organization expense and franchises. *See* ASSETS.

FIXED PRICE, a retail price on goods which is maintained by all distributing retailers of that product. Fixed prices are set by agreements between the manufacturers and the retailers of a product, and sometimes by agreements between combinations of producers and distributors. Fixed prices on a product prevent a few retailers from selling it at cut rates to draw trade and thereby make the prices of other retailers seem unfair to the public.

FIXTURES. There are two classes of property, real and personal. **PERSONAL PROPERTY** is usually movable. When it becomes permanently attached to land it usually becomes a part of the reality. (*See* REAL PROPERTY.) The question whether such attached articles become a part of the land depends upon the manner of the annexation, the adaptation to the use to which the land is devoted, and the intention of the parties. The controversy over removing fixtures usually arises between grantor and grantee, executor and devisee (*see* WILL), life-tenant and remainderman, and particularly between landlord and tenant. Annexations by a tenant are regarded usually as trade fixtures and are removable.

FIZEAU, ARMAND HIPPOLYTE LOUIS (1819-96), French physicist, was born at Paris, Sept. 13, 1819. In 1849 he undertook experiments into the nature of heat and light radiation, developing an accurate method of measuring heat expansion of bodies. His classic experiment, establishing a groundwork for later theories of RELATIVITY, proved that the speed of light in moving water was unaffected by the motion of the water. In 1860 he was elected to the French Academy and in 1878 he was attached to the Bureau of Longitudes. He died at Venteuil, Sept. 18, 1896.

FLAG, an emblem of a nation; usually made of cloth and flown from a staff. From a military standpoint flags are of two general classes, those flown from stationary masts over army posts, and those carried by troops in formation. The former are referred to by the general name flags. The latter are called colors when carried by dismounted troops and standards when carried by mounted troops. Colors and standards are more nearly square than flags and are made of silk with a knotted fringe of yellow on three sides. Flags, excluding colors and standards, are of three types—garrison, post and storm. The garrison flag is 20 ft. hoist (width) by 38 ft. fly (length). It is used on holidays and important occasions and is furnished only to an army post which is the permanent station of one of the following headquarters: army, army corps, department, corps area, division, brigade, regiment, coast artillery district, coast defense command, United States Military Academy, a

service school or an arsenal. The post flag is 10 ft. hoist by 19 ft. fly. It is furnished all garrisoned posts and is used in pleasant weather. The storm flag is 5 ft. hoist by 9½ ft. fly. It is used in all garrisoned posts in stormy weather.

In the army, personal flags indicating rank are provided for the President, the Secretary and Assistant Secretaries of War and general officers.

The term storm flag is also applied to signal flags hoisted on shore to warn mariners of an approaching storm. Small craft storm and hurricane warnings are given out by means of hoisting a red pennant for small craft and red-and-white pennants with square red flags with a black center displayed by day, and two red lanterns, one above the other, displayed by night, for large craft, indicating the approach of a storm of marked violence with winds beginning from the northeast. There are N.E., S.E., N.W., and S.W. storm warnings, respectively; and for hurricanes or gales, two square flags with black centers, one above the other, are displayed by day, or two red lanterns with a white lantern between, are displayed by night, the latter indicating the approach of a tropical hurricane or one of the extremely severe or dangerous storms which occasionally come across the Great Lakes or up the Atlantic Coast.

In addition to the various national flags, and code flags used for signalling, the vessels of the Navy carry special flags to indicate that the President, Vice President, Secretary of the Navy, and Assistant Secretaries of the Navy are individually or collectively on board. Special flags are used as distinguishing marks of flagships, of Admirals, Vice Admirals, and Rear Admirals. They are of blue bunting, hoisted at regulation masts, and contain four, three, or two white stars, according to the grade of the officer. When two or more officers of the same grade are in company, the senior flies the blue, the next in rank, the red, and the others, the white flag.

E. D. P.; R. E. C.

Use of Flag. The most general and appropriate use of the flag is as a symbol of authority and power. It is used in ceremonial observances to denote the sovereignty of a state, and also its equality. Recognition of the flag, generally reciprocal, is a mark of respect for the state which flies it. Improper use of a flag of truce or a national flag is forbidden by the HAGUE CONFERENCE agreements. It is generally contended that a man-of-war may under certain conditions make use of a false flag. By the DECLARATION OF LONDON, the enemy or neutral character of a vessel is governed by the flag she has the right to fly. By the same Declaration, the transfer of an enemy vessel to a neutral flag is valid, if effected before the breaking out of hostilities, and without intent to evade the consequences of enemy character. Such transfer after hostilities is generally void. The right to display a flag over embassies, legations and consulates is a right of the diplomatic and consular officers of a country.

C. E. MA.

FLAG, in botany, the name given to various species of IRIS, especially to the native tall blue irises of North

America and to numerous cultivated forms with blue or purple flowers.

FLAGELLANTS, a name applied to persons who, from religious motives, flog either themselves or one another. The custom of flagellation appeared in antiquity as a form of voluntary penance. It was not in this form but as a disciplinary punishment that flagellation appeared in early Christianity. During the 11th century, however, the older use of flagellation as a penance revived, particularly in the monasteries. This was an element present from the beginning in the Franciscan movement, but by the 13th century it had grown so enormously, particularly in Italy, as to pass the bounds of ecclesiastical organization and to bring papal disapproval upon the flagellant brotherhoods.

The passion for flagellation died out for a time only to revive more virulently in the 14th century. Large bands of flagellants began moving across Europe, and soon they began preaching that flagellation was the sole route to salvation and that the rites of the Church were useless. In self-defense Clement VI banned the movement, and severe repression gradually destroyed the heretical groups of fanatics and inevitably forced the Church itself to discourage the canonical use of flagellation as a penance lest it spread again into heresy. The custom still survives sporadically in Latin countries and appears at times of religious feasts or of great religious excitement.

FLAGG, ERNEST (1857-), American architect, was born in Brooklyn, N.Y., Feb. 6, 1857. Leaving the École des Beaux-Arts, Paris, in 1891 he opened an office in New York City. Many notable structures were designed by him, among them being the Singer building, New York City, which held the record as the tallest habitable structure in the world until the Woolworth building was completed. Among the important public buildings designed by Flagg were the present Corcoran Art Gallery, Washington; St. Luke's Hospital, New York; and the United States Naval Academy; though he also designed others, as well as many large private residences. His book, *Small Houses, Their Economic Design and Construction*, published in 1922, described a unique and economical method of erecting small domestic structures.

FLAGLER, HENRY M. (1830-1913), American capitalist, was born at Canandaigua, N.Y. Starting as a clerk in a country store, he became shortly after a manufacturer of salt and later a member of the firm Rockefeller, Andrew and Flagler, now known as the Standard Oil Company. He was prominently connected with this corporation until 1911. Flagler owned several palatial hotels in Florida and was chairman of the board of directors of the Florida East Coast Railway. He was also a director of the Western Union Telegraph and other large companies. He died at his home in West Palm Beach May 20, 1913.

FLAGSTAFF, a city in northern Arizona, the county seat of Coconino Co., situated 6,900 ft. above sea level at the foot of San Francisco Peak. It is

115 mi. northeast of Prescott, and is served by an airport, bus lines and the Santa Fé Railroad. Flagstaff is the seat of Lowell Observatory. Dry farming and lumbering are the leading interests in this region. Most unusual features of the landscape within a short distance are Coconino National Forest, the Hopi and Navajo Indian Reservations, cliff dwellings and Meteor Mountain. Flagstaff was founded in 1876. Pop. 1920, 3,186; 1930, 3,891.

FLAGSTONE. See SANDSTONE.

FLAMBOYANT STYLE, in architecture, the late Gothic style of France; sometimes also used of the late Gothic of Flanders, Germany and Spain, covering a period extending generally from about 1400 to well into the 16th century. It receives its name from the flame-like shapes common in the tracery. These result from the constant use of lines of reverse curvature, that allow endless varieties of sinuous patterns. The origin of flamboyant tracery is to be found in the English curvilinear tracery of the 14th century, which used forms somewhat similar. The French developments are freer, more nervous, often more complicated. Structurally the flamboyant architects gave new life to the Gothic tradition by many interesting experiments in the attempt to find an entirely expressive treatment, and to carry still further the Gothic idea of slim skeleton construction in stone. Thus vaulting ribs were sharply molded and pier capitals were omitted, so that the ribs and arch moldings either died into plain pier surfaces, or were carried unbroken down to near the floor. Walls were reduced to the smallest possible areas, and many flamboyant churches were without triforia.

Frequently the interiors thus produced are brilliant, but hard and cold, and the stained glass of the period, abounding in cold yellows and with large areas of grisaille, or simple patterning in a single tone, adds to this effect. In decorative detail, there is an extraordinary luxuriance. Pierced traceried gables are common, and pier and buttress surfaces often broken up by small decorative buttress shapes and much wall tracery. Moldings that intersect are carved as if they penetrated each other, and bases are high and complex. There are many canopies, each often a marvel of delicate, lace-like stone cutting. Foliage is concentrated in hollow moldings and is used for crockets, where it is broken up like finely divided seaweed. Architectural sculpture is small in scale, and the search for dramatic expression leads often to a loss of monumental dignity. The style is frequently at its best in secular and domestic work. Towards the end of the period the desire for richness went to riotous, decadent extravagances, and the gradual infiltration of classic detail led to incongruous round arches and ugly circular tracery. From the richness and occasionally bizarre quality of this late Gothic style, the term flamboyant is often used in art criticism of any work characterized by ostentatious or even grotesque over-richness. For bibliography see GOTHIC ARCHITECTURE. T. F. H.

FLAME is produced by the rapid combustion of gas or vapor, usually with the oxygen of the air.

The flame produced when gas burns from a simple jet consists of an inner portion, composed of unconsumed gas; a central luminous region, in which the chemical reaction of burning is occurring; and an outer portion, an invisible envelope, consisting of the gaseous products of combustion. A solid or liquid always volatilizes during combustion, and the flames from them are of the same structure as those from gases.

The luminosity of flames is due largely to unconsumed particles of carbon which are heated to incandescence. When air is mixed with the gas before combustion, as in the BUNSEN BURNER, the degree of combustion is increased and greater heat and reduced luminosity result. Mixing pure oxygen with the gas, as in the oxy-hydrogen or oxy-acetylene flames, greatly intensifies the heat produced. A suitable noncombustible mantle heated in a Bunsen flame gives off intense light (see WELSBACH BURNER).

The rate of propagation of the flame through a mixture of air and an inflammable gas or vapor is of great importance in the theory of GAS ENGINES and in the study of explosions. W. W. S.

FLAME-TREE (*Brachychiton acerifolium*), a handsome evergreen tree of the sterculia family native to New South Wales and cultivated for ornament in California and other warm regions. It grows 60 ft. high, bearing large, shining, deeply-lobed leaves and brilliant scarlet flowers. The fire-tree (*Nuytsia floribunda*), a small, profusely-blooming tree of southwestern Australia with bright orange-colored flowers, is also called flame-tree.

FLAMINGO, the name applied to members of a family (*Phoenicopteridae*) of large web-footed wading birds intermediate between the storks and geese. There are some six species found widely in salt



DRAWING BY GEORGE MIKSCH SUTTON

AMERICAN FLAMINGO

marshes and lagoons in tropical and subtropical regions. They are of striking appearance with extremely long necks and legs, both bills bent abruptly downward near the middle, and brilliant rosy-white or scarlet plumage with black on the wings. Their food consists chiefly on their crustaceans and mollusks which they scoop up from the soft mud in shallow waters with a backward movement of the head and bill. They breed in large colonies, usually on mud flats, building rude

mud nests, about a foot high, and laying one or two bluish eggs. Their loud, honking, goose-like cries may be heard for nearly a mile.

Of the four New World species only one (*Phoenicopterus ruber*), a resident of the West Indies, ranges northward as far as southern Florida, where it is

exceedingly rare. It stands over 4 ft. high and has bright scarlet plumage. The European flamingo (*P. antiquorum*), with rosy-white plumage, ranges over southern Europe, warmer Asia, and north Africa. This species, often seen in zoological parks, is frequently mentioned in ancient writings, especially in those of the Romans, who prized it for food and considered its fatty tongue a rare delicacy.

FLAMMARION, CAMILLE (1842-1925), French astronomer and writer, was born at Montigny le Roi, Feb. 26, 1842. Educated at Langres and the Sorbonne he joined the Paris observatory in 1858 and the Bureau of Longitudes in 1862. He maintained a private observatory at Juvisy where he made many studies of Mars. His writings, many of which were influential in popularizing information about astronomy throughout the world, included *The Plurality of Inhabited Worlds*, 1862; *Astronomy*, 1882; *The Planet Mars, Its Habitable Conditions*, 1892; *The End of the World*, 1893, and, in addition to other astronomical papers, spiritual and celestial romances. He died at Juvisy, June 4, 1925.

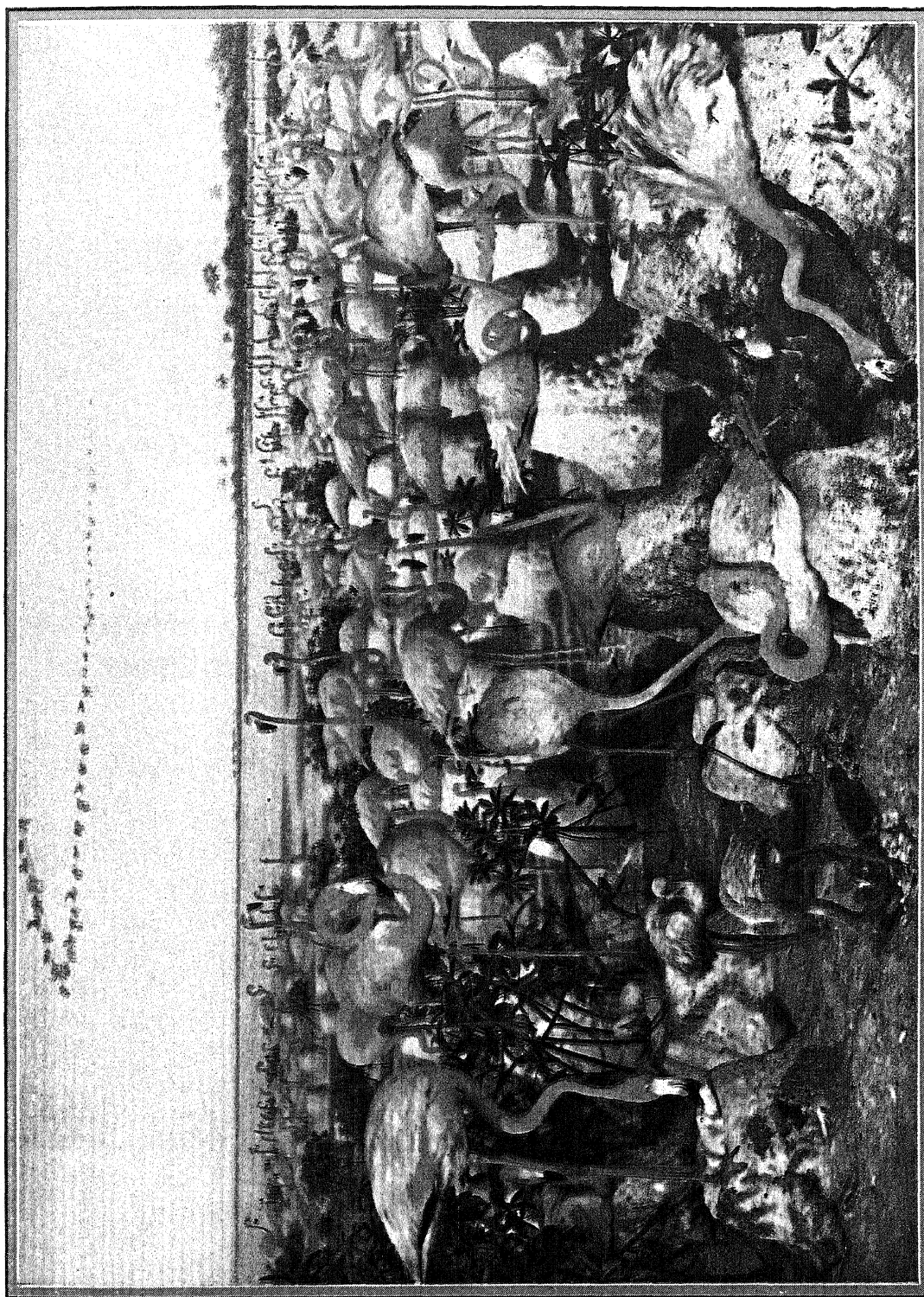
FLAMSTEED, JOHN (1646-1719), English astronomer, was born at Denby, Aug. 19, 1646. In 1675 he founded the Observatory of Greenwich. His *Historia Coelestis Britannica* issued in 1712 catalogued the positions of 2,848 stars. Halley reissued this volume in 1725 and on this base was prepared the great *Celestial Atlas* (Atlas Coelestis) of 1729 containing 25 maps, and a further issue of 1753 with 28 maps. He died at London, Dec. 31, 1719.

FLANAGAN, JOHN (1865-), American sculptor, was born at Newark, N.J., in 1865. He studied with AUGUSTUS SAINT-GAUDENS and at the Ecole des Beaux Arts, Paris. His works include the monumental clock in the Library of Congress, Washington; the statue of Joseph Henry; the design for the Verdun medal; decorative groups for the St. Louis Exposition, and various works in the Metropolitan Museum and the Luxembourg Museum.

FLANDERS (Flemish, *Vlaanderen*), the name given to the district of The Netherlands bounded by the lower Scheldt, the North Sea, and the duchies of Artois, Hainault and Brabant. In the Middle Ages this territory became a feudal county owing allegiance at first to both the Empire and to France. In the 12th century Flanders came under an Alsatian house which united Hainault to it. In the middle of the 14th century it became little more than a French province, although much against the will of the Flemings who fought for their independence in the Battle of the Spurs in 1302. In 1369 Flanders became by marriage part of the holdings of the Duke of Burgundy. From that time on its history forms part of that of Burgundy, The Netherlands and Belgium. To-day the term Flanders refers to that part of Belgium in which the Flemish language is the predominant tongue, and should be distinguished from the Belgian provinces of East and West Flanders.

FLANNEL BUSH (*Fremontia californica*), a loosely branching evergreen shrub of the sterculia

FLAMINGO

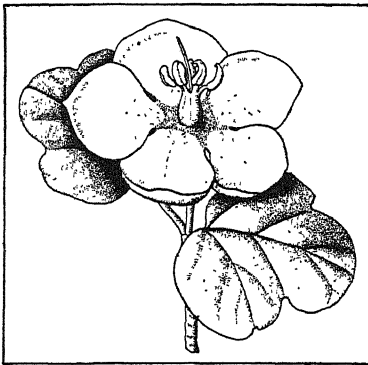


COURTESY AMERICAN MUSEUM OF NATURAL HISTORY

A FLAMINGO COLONY IN THE BAHAMAS

Reproduction of a scene in a flamingo colony. The pose of every bird is based on photographs made from a blind concealed in the heart of the colony. Both the male and female incubate the eggs in the nests, which are constructed of mud and are raised from eight to fourteen inches above the ground to protect the contents from the water. The plumage of the young birds is of a brownish gray color.

family, found on mountain slopes in California. It grows 6 to 10 ft. high, sometimes becoming tree-like, bearing many short branchlets and small leaves covered below with a dense grayish-white felt. The showy, persistent, yellow flowers, $1\frac{1}{2}$ to 2 in. broad, are flannel-like in texture.



FROM JEPSON, MAN. FL. PLANTS CALIF., COPYRIGHT

FLANNEL BUSH

FLASH POINT. See ABEL TEST; also ASPHALT TESTING.

FLASH SPECTRUM, the observation made of the spectrum of the SUN at an eclipse, during the instant when the moon has covered the PHOTOSPHERE but not the CHROMOSPHERE.

FLATBUSH, a part of Brooklyn borough, Kings Co., N.Y. It was settled by the Dutch in 1635. Known under various names, finally the village became Flatbush. It was the scene of the Battle of Flatbush, often called the Battle of LONG ISLAND, Aug. 27, 1776. The township became a portion of Greater New York in 1898.

FLAT CAR. See RAILROAD ROLLING STOCK.

FLATFISHES, a distinct group (*Heterosomata*) of spiny-rayed marine fishes, including many species highly valued for food, such as the HALIBUT, SOLE, FLOUNDER, TURBOT and PLAICE. The flatfishes, which are characterized by greatly compressed bodies, swim horizontally and have both eyes and their distinctive coloration on the side that is uppermost; the other or lower side is blind and usually plain white in color. When very young, flatfishes have symmetrical bodies and swim upright in the water. Soon a tendency to rest exclusively on one side on the bottom develops, and the skull gradually becomes twisted bringing both eyes to the side which lies uppermost. Flatfishes are found in most seas, keeping close to the bottom and feeding on various small forms of marine life. Some, however, as the halibut, actively pursue other fishes, swimming in a rapid undulatory manner.

FLAT FOOT. The weight of the body is transmitted from the ankle joint to the arch of bones which composes the foot. The bases of the arch are the ball of the foot and the heel respectively. The bones are arranged to form, in reality, two arches, the medial one being supported by the first and second metatarsal bones, and the latter one by the other three. It is the former one which is most

likely to give way. This is a result of the weakening of the ligaments of the foot and of muscles which attach onto the arch. The best treatment of flat foot consists in strengthening these muscles. Arch supports only weaken the arch further by putting it at rest, though they may be necessary in painful cases.

FLATHEAD, a collective name applied to various Indian tribes that practiced artificial deformation of the head. The tribes included in this category were the Catawba and Choctaw and other Muskhogean tribes of the southeastern culture area, the Chinook, the Haida and most of the Puget Sound and British Columbia Salish. The name has caused some confusion because the Salish proper, who did not follow the practice of head deformation, have been called Flathead. It has therefore been used indiscriminately either as a generic term or applied to a specific tribe.

FLAUBERT, GUSTAVE (1821-80), French novelist, was born at Rouen, Dec. 12, 1821. Possessing a private income, in 1846 he settled with his mother, now a widow, in a pleasant country home at Croisset, near Rouen. Here he lived for the rest of his life, toiling like a slave to attain absolute perfection of literary style. In this object it is conceded that he was entirely successful with his first novel, *MADAME BOVARY*. It was published serially in the *Revue de Paris* in 1857, and editor and author were defendants in an action brought against them by the Government on the charge of the novel's immorality. Flaubert and his editor were acquitted, and in book form *Madame Bovary* met with great success. Other novels followed slowly, for Flaubert held the belief that one word, and one word only, could properly express the author's meaning, and sometimes the search for the right word meant a matter of hours. But neither *L'Education Sentimentale* nor *SALAMMBÔ* nor *Bouvard et Pécuchet* equalled *Madame Bovary*. Nevertheless, Flaubert is acknowledged as one of the greatest of French novelists, his influence being immense and his fame ever-increasing. His last years were lonely and sad, ill health and financial difficulties adding to the depression created by family losses and his country's defeat in the Franco-Prussian War. Flaubert died at Croisset, May 8, 1880. See also FRENCH LITERATURE.

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FLAX. See LINEN.

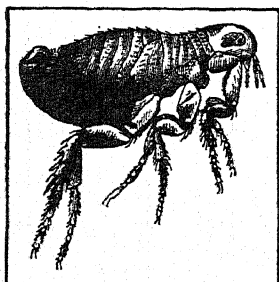
FLAX, an important economic plant, valued both for the textile fiber obtained from its stem and for the LINSEED OIL expressed from its seed. The common flax (*Linum usitatissimum*) is a slender annual of the flax family (*Linaceae*). It grows from 1 to 3 ft. high, bearing small narrow leaves and numerous bright blue flowers, $\frac{1}{2}$ inch across, in a leafy cluster. The globular podlike fruit or capsule is partitioned into 10 cells, each containing a single, flattened, glossy, brownish seed. The plant, a native of western Asia, has been cultivated since prehistoric times. There are evidences that it was grown in Chaldea before Babylon was founded. The ancient Egyptians and Hebrews made use of linen fabrics. For a long period

before the Christian Era the Romans imported fine linen from Spain. From the region of its most ancient use, the cultivation of flax has spread throughout the world. As a fiber plant, flax stands second only to cotton. FLAX FIBER is produced most extensively in Russia, Hungary, Belgium, Holland, France, and Ireland. In volume produced Russia far surpasses other countries but in quality the maritime countries of western Europe excel. The commercial crop of flaxseed is grown chiefly in the United States, Canada, Argentina, Russia and India. In America little attempt is made to grow flax fiber. Besides its chief use for the manufacture of linen, flax fiber is employed in making thread, warp, cordage, sailcloth and numerous other articles. See FIBER PLANTS.

FLAXSEED PRODUCTION IN THE UNITED STATES
7-Year Average, 1924-30

Division	Acreage (1,000 Ac.)	Production (1,000 Bu.)	% of Tot. Prod.
UNITED STATES	3,137	22,830	100.0
LEADING STATES:			
North Dakota	1,499	9,779	42.8
Minnesota	715	6,907	30.3
South Dakota	577	4,007	17.6
Montana	262	1,442	6.3

FLAXMAN, JOHN (1755-1826), English sculptor and illustrator, was born at York, July 6, 1755. He evinced a precocious capacity to handle both clay and pencil and in 1775, apprenticed himself to JOSIAH WEDGEWOOD. The designs which he executed for the house of Wedgwood during the next 12 years did much to perfect his bas-relief technique and to raise the reputation of this already famous establishment. In 1787 Flaxman went to Italy, where he made a European reputation by his outline illustrations for Homer, Virgil, Dante and Aeschylus. At the same time he became even more enamored of classic art which, combined with an element of the Baroque and weakened by the low level of English taste at the time, turned him from his fine, early relief work to memorial monuments in the round. Flaxman's heavy winged angels and symbolical high-relief tomb figures



HUMAN FLEA
Greatly enlarged

are a triumph of bad taste, and he is best remembered by such works as the wax figure of a seated child in the South Kensington Museum, the *Wedgwood Dancing Hours* and the illustrations for Hesiod, engraved by his friend William Blake. He died at London, Dec. 7, 1826.

FLEA, an insect of the order *Siphonaptera* (or *Suctoria*). Adults are small wingless creatures with long legs, fitting them for leaping. They suck the blood of mammals, occasionally attacking birds. Larvæ are not parasitic. They live in the sleeping quarters of infested animals. Three species of fleas may be found in human dwellings. These are

the human flea (*Pulex irritans*), the dog flea (*Ctenocephalus canis*), and the cat flea (*C. felis*). Fleas are known to be carriers of bubonic plague. Principally a disease of rodents, especially rats, it may be transmitted to man by fleas. Persian insect powder may be used to free cats or dogs of fleas. Bedding of kennels should be frequently removed and burned, and kerosene emulsion used freely inside the kennel.

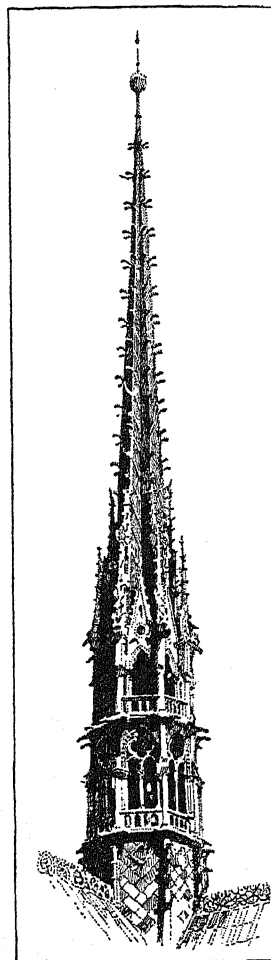
J. R. T.

FLEA-BEETLE, a popular term for a large group of leaf eating beetles of the family *Chrysomelidæ*. The adult beetles feed on the foliage of the plants which they infest, eating little holes. Their larvæ live on the roots of plants, or are miners in the green tissues. These beetles are serious enemies of cabbage, hop, turnip, cucumber, spinach, melon, grape, strawberry, potato, tobacco, eggplant, tomato, sweet potato, sugar beet and other related plants. Bordeaux mixture is used as a repellent, and lead arsenate or Paris green as a poison. The two are generally mixed.

FLÈCHE, originally any spire; now generally used in English only for subordinate spires which crown some medieval church roofs directly, without the interposition of a tower. Such flèches are particularly characteristic of French Gothic architecture from the early 13th century on. Earlier examples, like that of Notre Dame in Paris, are remarkable examples of timber construction, with a rich decorative treatment based on the structural elements. All of the timber is protected by lead sheets in which the ornament is formed. Later examples are either of great flamboyant lavishness, like that of Amiens, 15th century or severely simple, and covered with slate instead of lead, as in Orbaix, 14th century, or Eu, 15th century.

See Viollet-le-Duc, *Dictionnaire raisonné de l'architecture française*, 1852-1875, article Flèche.

FLECKER, JAMES ELROY (1884-1915), English poet, was born in London, Nov. 5, 1884. He was educated at Oxford and Cambridge, and entered the consular service. In 1910 he was sent to Constantinople, and the next year to Smyrna; but his health



FLÈCHE, NOTRE DAME, PARIS

failed and in 1913 he sought recovery in Switzerland. Meantime, in 1910 and 1913 respectively, his *Twenty-six Poems* and the *Golden Journey to Samarkand* had appeared, and he continued to write despite his illness. *Hassan*, a poetic drama, was posthumously published. Flecker's work is strikingly individual, the sincere product of inner experience. His collected verse was published in 1916. The poet died at Davos, Switzerland, Jan. 3, 1915.

FLEET LOGISTICS. See LOGISTICS, FLEET.

FLEET, NAVAL, in general, the whole naval force of a country; a collection of ships, either war or merchant. A small fleet is called a flotilla.

Fleets of great size were early used. The Persians first assembled great numbers of ships, and the Carthaginians and Romans counted them by hundreds. The Danes and Normans, in their early incursions, had as many as 600 vessels; and William the Conqueror went to England with 1,000 vessels. As ships were increased in size, however, a change took place, and the Spanish Armada consisted of some 150 vessels of from 300 to 1,200 tons.

Since the World War, particularly, it has been customary to divide fleets into forces by types and duties to be performed. On Apr. 1, 1931, the command of the United States Fleet was vested in a "Commander-in-Chief, U.S. Fleet," and this fleet itself was divided for peace time purposes into four forces, designated as Battle Force, U.S. Fleet; Scouting Force, U.S. Fleet; Submarine Force, U.S. Fleet; Base Force, U.S. Fleet. R. E. C.

FLEET STREET, a street in London that is famous for its literary and journalistic associations. It extends from Ludgate Circus to the east end of the Strand, and derives its name from the Old Fleet River, now arched over and used only as a sewer. Fleet Street, always famous for its inns and taverns, has been the center of British newspaperdom since the 18th century and the days of SAMUEL JOHNSON.

FLEMING, PAUL (1609-40), German lyric poet, was born in Hartenstein, Saxony, Oct. 5, 1609. He studied medicine at Leipzig, but became an *attaché* of the ambassador to Russia and Persia. Fleming's lyrics are accounted the most characteristic of the Silesian school of poets headed by Opitz. They exhibit a devout man giving lyrical expression to his love for nature and embodying his piety in the form of hymns that are still sung. The poems were first published in 1642. Fleming died at Hamburg, Apr. 2, 1640.

FLEMING, SIR STANFORD (1827-1915), Canadian engineer and scientist, was born at Kirkcaldy, Fifeshire, Scotland, Jan. 7, 1827. In 1845 he went to Canada, where he became engineer-in-chief of the first transcontinental line constructed by the Canadian Pacific Railway. He was instrumental in making Greenwich meridian time common to all nations. Fleming's chief publications were *The Inter-Colonial*, 1876, and *England and Canada*, 1884. He died at Halifax, N.S., July 22, 1915.

FLEMING VS. PAGE, in United States constitutional history, an action brought before the Supreme

Court by Fleming and Marshall, merchants, against the Collector of the Port of Philadelphia, to recover duties paid under protest on merchandise imported into Philadelphia from Tampico in the spring of 1847. Tampico was then under military possession of the United States. (See MEXICAN WAR.) The plaintiff's contention was that such possession established the sovereignty of the United States, and that therefore Tampico was not at the time a foreign port. Chief Justice Taney, in denying the contention, 1851, set a notable principle: "The genius and character of our institutions are peaceful. . . . A war, therefore, declared by Congress, can never be presumed to be waged for the purpose of conquest or the acquisition of territory; nor does the law declaring war imply an authority to the President to enlarge the limits of the United States by subjugating the enemy's country."

FLEMISH LITERATURE, the literature of those parts of Belgium and France which were formerly known as Flanders. See BELGIAN LITERATURE.

FLEMISH MOVEMENT IN BELGIUM, THE. Belgium is linguistically divided almost equally by a line running from a point south of Ypres to Maastricht, the population north of that line speaking Dutch or Dutch dialects known as Flemish, essentially dialects of Low German, except in the cities where there are important groups of Gallicized Flemings, and the population south of it speaking French or French dialects known as Walloon. In the Middle Ages and early modern times the Flemings attained a high degree of prosperity and culture, but because of foreign domination, economic decay, and the favor enjoyed by the French language and French culture in the 18th century, the Flemish language and Flemish culture gave way to things French.

The revolt of the Belgian provinces from the Kingdom of the United Netherlands in 1830 (see BELGIUM, HISTORY OF), was led by those of French interests, and French was made the official language of the new state. Later, in the romantic period, Flemish literature and history aroused among the Flemings an intense interest and admiration for their past and hopes for the future. Praises of the cultural accomplishments of Flemings were sung to the accompaniment of agitation for the use of the Dutch language in law courts, in civil administration, in schools and in universities. This movement had some results before the World War, some Flemish writers using Dutch instead of French and Flemish being put on an equality with French before the law. The Flemish leaders, however, were bent on securing equality of the two languages in all state matters, and this they failed to do.

When the World War broke out, the Flemings rallied to Belgium's defense, but during the period of German occupation some of their leaders, although not the outstanding ones, sought to realize the Flemish ideals with German aid. The Germans took advantage of the Flemish movement in the expectation that, if they effected the desired reforms, the Flemings

would work in harmony with them. To this end the use of Flemish was rigidly adhered to in state affairs in the Flemish speaking districts, instruction in the University of Ghent was given in Flemish, and finally Belgium was divided for administrative purposes into two districts—the Flemish and the Walloon.

Upon the declaration of peace and the restoration of Belgium those Flemings who had cooperated with the Germans in establishing an autonomous Flanders, the so-called Activists, were declared traitors. Many of them fled to Holland, but some remained behind to face Belgian justice. The sentences which were meted out varied from short terms of imprisonment to capital punishment. Flemish agitation then became more radical than ever. A nationalist political party, the *Frontparty*, was formed for the purpose of establishing either an autonomous Flanders, an independent Flemish state, or a union of Flanders with Holland, a party which increased its popular vote from 57,000 in 1921 to 133,000 in 1929. Flemish writers and teachers turned their efforts toward propaganda for reform. They, with the *Frontents*, forced the milder but more numerous Flemish elements in the Catholic Party to secure amnesty for the Flemish activists, permission to use Flemish in state services, the division of the army into French and Flemish regiments, and the exclusive use of Flemish at the University of Ghent. These triumphs were not achieved without bitterness on the part of the Belgians of French sympathies who wanted to preserve the *status quo* and of the Walloons who resented the advances of Flemings in the affairs of state. There is evidence at the present time of a Walloon movement, a revival of Walloon culture and patriotism, to offset the growing strength of the Flemish movement.

S. B. C.

See S. B. Clough, *A History of the Flemish Movement in Belgium*, 1930.

FLENSBURG, capital of Prussian Schleswig, near the Danish frontier on the Flensburg Fjord. It has navigation, marine and other schools, docks and machine factories. It has been a free port since 1923. A city in 1284, Flensburg became Danish in 1848 and Prussian in 1867. From January to June, 1925, it was occupied by the Allies as the center of the Schleswig plebiscite, but it remained German. A noteworthy old building is the Church of St. Nicholas, built in 1390. The city is the birthplace of Dr. Eckener. Pop. 1925, 63,139.

FLETCHER, GILES (1588-1623), English poet, was born probably at London in 1588. His father was Giles Fletcher, Queen Elizabeth's ambassador to Russia. The young Fletcher was educated at Cambridge and became a clergyman. His sermons at St. Mary's attracted wide attention, one of the most famous being *The Reward of the Faithful in Fear of Death*. His poems express ardent religious devotion. Perhaps the best known of these is *Christ's Victories and Triumph*. Fletcher was greatly influenced by EDMUND SPENSER. And he, on his part, was carefully

read by MILTON. He died at his living of Alderton in Suffolk. Papers of administration were granted his widow, Nov. 12, 1623.

FLETCHER, JOHN (1579-1625), English dramatist, was born at Rye, Sussex, in Dec. 1579. His father became Bishop of Bristol, Worcester and London, and attended Mary Stuart in her last hours. The poet is assumed to be the John Fletcher who entered Benet College (Corpus Christi), Cambridge, Oct. 15, 1591. He came under Jonson's patronage, and with Beaumont prefixed some verse to *Volpone*. (See BEAUMONT, FRANCIS.) From about 1600 Beaumont and Fletcher collaborated, and in Aubrey's account, lived a bachelor life together, "on the Bank-side, not far from the playhouse." *The Woman Hater*, produced in 1607, was probably Fletcher's first play. In association with Beaumont his work is difficult to place, but it is known that in Beaumont's life he wrote *The Knight of the Burning Pestle*, 1613, *Cupid's Revenge*, 1615, and *The Scornful Lady*. After Beaumont's death in 1616, the four quartos written with Beaumont were published: *A King and No King*, 1619, *The Maid's Tragedy*, *Philastor*, 1620, and *Thierry and Theodoret*. About 27 of the plays attributed to Beaumont and Fletcher are considered the work of Fletcher alone. Only 14 are established as the work of Beaumont and Fletcher together, and others were written with Massinger, Rowley and others. Certain passages in the *Two Noble Kinsmen* are by Shakespeare. Fletcher died in the Great Plague, and was buried Aug. 29, 1625, at St. Saviour's, Southwark, London.

FLETCHER, PHINEAS (1582-1650), English poet and dramatist, brother of GILES FLETCHER, was born in Cranbrook, Kent, and baptized, Apr. 8, 1582. His father was Giles Fletcher, Elder (1549-1611), whose brother Richard, afterwards Bishop of London, was father of JOHN FLETCHER, the famous dramatist. Phineas Fletcher was educated at Eton and Cambridge, and was made a fellow of his college. He produced his pastoral, *Sicelides*, at the University in 1615. In 1621 he was Rector of Hilgay, Norfolk, and attacked the Jesuits in his poem, *Locustae*, 1627. At 51 he published his *Piscatory Eclogues* and his poem *The Purple Island, or the Isle of Man*, 1633. Fletcher died at Hilgay in 1650.

FLETCHER VS. PECK, 1810, the first instance in which the United States Supreme Court declared unconstitutional an act of a state legislature. The litigation, arising from the YAZOO CLAIMS, was a test case to determine the constitutionality of the act of the Georgia legislature, 1796, repealing certain land grants. Chief Justice Marshall, in rendering the decision, applied that part of the Federal Constitution forbidding any state to impair the obligation of contracts, and declared the act of 1796 null and void.

FLETTNER MOTOR, a mechanical method of utilizing the power of winds, differing from WINDMILLS in principle. The scheme was developed by Anton Flettner, a German engineer, and its essential element is a large vertical cylinder rotated by a com-

paratively small source of power. This rotation, together with the force of the wind, creates a partial vacuum on one side, and builds up a pressure on the other side of the cylinder—thus producing an unbalanced condition of forces that tends to move the cylinder in a direction at right angles to the wind. The principle upon which this motor acts is known as the **MAGNUS EFFECT**. Although at one time a Flettner rotorship crossed the Atlantic from Germany, holding out promises of economic development, the principle was not utilized further until 1932 when a large power plant operating on this principle was constructed at Burlington, N. J.

FLEUR-DE-LIS, as translated from the French, "flower of the lily," a name given to an ornamental device comprising three likenesses of the white lily or iris plant, one curving outward from either side of the center one which is erect. It originated in ancient times, being used widely as an ornament, and is thought to have been a religious symbol of the Egyptians. In the latter part of the 17th century it was adopted as the official emblem of French royalty. It became a common design of heraldry and was a part of the armorial bearings of several countries.

FLEURY, CLAUDE (1640-1723), French Church historian, was born Dec. 6, 1640, at Paris. After practicing law, he changed to theology and took priest's orders. Fleury distinguished himself as the tutor of the young princes of Conti and of Vermandois, and later as the sub-preceptor of the royal grandchildren. From 1716 to 1722 he was the confessor of the young King Louis XV. Among the most important of Fleury's numerous works is *Histoire Ecclésiastique*. He died July 14, 1723.

FLEXNER, ABRAHAM (1866-), American educator, was born at Louisville, Ky., Nov. 13, 1866. He graduated from Johns Hopkins (A.B.) in 1886, from Harvard (A.M.) in 1906 and studied at the University of Berlin from 1906-07. For a time he taught in the Louisville high school. From 1908-12 he was with the Carnegie Foundation for the Advancement of Teaching. (See **CARNEGIE TRUSTS**.) In 1912 he was made assistant secretary to the **GENERAL EDUCATION BOARD** and in 1917 secretary, serving until 1928. From 1925-28 he was director of studies and medical education and had supervision of the expenditure of \$50,000,000 given by John D. Rockefeller for the advancement of medical education. In 1930 he was made director of the Institute for Advanced Study in New Jersey.

Among his books are *Medical Education in the United States and Canada*, 1910; *Prostitution in Europe*, 1914; *A Modern College*, 1923; and *Universities: American, English and German*, 1930.

FLEXNER, SIMON (1863-), American pathologist, was born in Louisville, Ky., March 25, 1863. He graduated from the University of Louisville in 1889, and took postgraduate work at Johns Hopkins University and the Universities of Strasbourg, Berlin and Prague, and at the Pasteur Institute. He was associate professor and later professor of pathologic an-

atomy at Johns Hopkins in 1889 to 1899, and became professor of pathology at the University of Pennsylvania in 1899. He was appointed director of laboratories at the Rockefeller Institute for Medical Research in 1903, which position he now holds. Doctor Simon Flexner is noted for his work on terminal infections, experimental work on venoms, etiology and therapy of cerebrospinal meningitis, infantile paralysis or acute anterior poliomyelitis, encephalitis and herpes, and experimental epidemiology. M. F.

FLICKER, one of the common names given to various species of woodpecker, especially to the golden-winged woodpecker (*Colaptes auratus*), a common woodland bird of the eastern United States and Canada. See **WOODPECKER**.

FLIES, two-winged insects of the very large order *Diptera*. The second pair of wings is represented by a pair of knob-like structures called halteres. The mouth parts of adults are fitted for sucking. Metamorphosis is complete. The eggs are usually laid on or near the food of the larvæ. These are cylindrical, legless creatures commonly known as maggots. Many species feed on decaying plant or animal material. Others are parasitic upon other insects. The last larval skin serves as a cocoon, and is known as the puparium. This order is very important, as many species of flies are serious pests of man and domesticated animals. They may be injurious because of their blood-sucking habits, or because they transmit disease. Those species which feed on other insects are useful to man.

The term "fly" is often compounded with some other word, as the common name of some insect of a very different order. Thus mayflies belong to the order *Ephemera*. Chalcis-flies are hymenopterous insects, while fireflies are beetles. See also **BLACK-FLY**; **BOTFLY**; **DEER-FLY**; **GAD-FLY**; **HORN FLY**; **HOUSE FLY**. J. R. T.

FLIGHT COMMANDER, in the Army Air Corps, an officer who trains and leads a flight of pursuit, attack or bombardment of observation planes at the orders of his immediate superior, the squadron commander. Theoretically a captain, the flight commander is in actuality usually a second lieutenant. He flies at the head of the flight which comprises from five to eight planes in V or double V formation. The flight commander may also act as squadron engineer or operations or armament officer. See also **MILITARY AVIATION**; **NAVAL AVIATION**.

FLINT, AUSTIN (1812-1886), noted American physician, was born in Petersham, Massachusetts, October 20, 1812. He received his degree of M.D. from Harvard University in 1833. He was professor of medicine in Buffalo Medical College from 1847 to 1852; professor of medicine in the University of Louisville, 1852-1856, and professor of medicine in Bellevue Hospital Medical College, 1861-1886. He was noted authority on medical practice and auscultation, and contributed several textbooks to medical literature. His death occurred in New York on March 13, 1886.

FLINT, AUSTIN, JR. (1836-1915), eminent physiologist, was born in Northampton, Massachusetts, March 28, 1836. He attended Harvard University, University of Louisville, and graduated from Jefferson Medical College, Philadelphia, in 1857. He was professor of physiology at the University of Buffalo in 1858, and occupied this position in several universities, his last appointment being at Cornell University Medical College from 1898-1906. His contributions included several textbooks on physiology and other medical subjects. He died in New York City on September 23, 1915.

FLINT, CHARLES WESLEY (1878-), American educator, was born at Stouffville, Ont., Nov. 14, 1878. He studied at the University of Toronto, Drew Theological Seminary and Columbia. From 1900-15 he preached in Methodist Episcopal churches in Iowa and New York. In the latter year he was elected president of Cornell College, and in 1922 became chancellor of Syracuse University. Flint has taken an active part in discussions of prohibition, being opposed to repeal and publicly challenging the motives of the Association Against Prohibition Amendment in the elections of 1930.

FLINT, a translucent, smoky gray or brown to black form of chalcedonic QUARTZ. It consists largely of the siliceous skeletons and spicules secreted by such marine life as DIATOMS and SPONGES, colored by carbonaceous matter. Flint usually contains a certain amount of OPAL, an amorphous or non-crystalline quartz. This is soluble and when dissolved out of the surface leaves a typically white, porous and opaque coating of crystalline silica, characteristic of flint nodules. These nodules are commonly found in chalk formations, as at Dover, England. They are of such wide distribution in limestone beds that primitive man used the sharp cutting edges, into which these nodules fractured, to make his weapons and implements of flint. Impure, opaque flint is often called chert. Flint pebbles are used in ore-grinding mills.

FLINT, a city in southeastern Michigan, the county seat of Genesee Co., situated 61 mi. northwest of Detroit. It is served by bus and truck lines and two railroads. There are three airports. Flint is an industrial center, manufacturing automobiles and automobile accessories, paint, varnish and flour. The total manufactured output for 1927 was worth \$600,355,781. The wholesale trade, 1929, amounted to \$22,902,646; the retail business to \$94,520,688. Jacob Smith, a fur trader, came here in 1819. The city was chartered in 1855. Flint earned its title of "Vehicle City" in the late days of the 19th century, when it was a great carriage manufacturing center. Pop. 1920, 91,599; 1930, 156,492.

FLINT RIVER, a river of southwestern Georgia, rising about 10 mi. south of Atlanta. It flows generally south and southwest for 285 mi. and unites with the Chattahoochee at the southwest extremity of Georgia to form the Apalachicola. This stream drains 8,200 sq. mi. of the central and southern areas of Georgia and affords excellent water power due to

shoals at intervals on its course. Yellow Jacket Shoals which occur in Upson Co. have a fall of 65 ft. in $1\frac{1}{2}$ mi., all of which can be utilized. The river is navigable to Albany, Ga., and is used for transporting naval stores, logs and food products.

FLOATING BODIES, EQUILIBRIUM OF. A body immersed in a fluid is buoyed up by a force equal to the weight of the fluid displaced. This is the principle of ARCHIMEDES. With respect to floating bodies the principle may be stated as follows: a floating body sinks in a liquid to such a depth that the weight of the liquid displaced equals the weight of the floating body. When a boat is launched it sinks until it displaces an amount of water equal to its own weight. The displacement of a boat is independent of its design or shape.

The weight of a floating body acts downward through its center of gravity. The buoyant force acts upward through the center of gravity of the displaced liquid, the so-called center of pressure. The floating body is in equilibrium when these two forces are equal and opposite. If, when a floating body is slightly displaced from its position of equilibrium

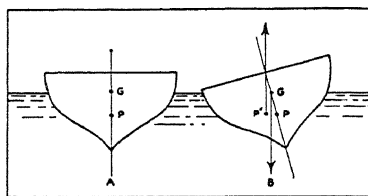


FIG. 1. FLOATING BODY IN STABLE EQUILIBRIUM

the couple resulting from its own weight and the buoyant force tends to restore it to the original position, the equilibrium is said to be stable. If *G*, Fig. 1A, is the center of gravity of a floating body and *I* is the center of pressure, the two points must be in a vertical line if the body is in equilibrium. If the body is displaced into the position shown in Fig. 1B the center of pressure is no longer at *P* but is displaced to some point, *P'*. The body is then seen to be acted upon by a couple which tends to restore

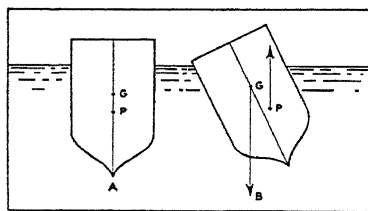


FIG. 2. FLOATING BODY IN UNSTABLE EQUILIBRIUM

it to position *a*. In Fig. 2A, the couple brought into play when the body is displaced as in Fig. 1B tends to increase the displacement; hence, the condition here shown is unstable. The principles are important in ship design. Ballast is used to keep the center of gravity low and thus avoid the condition shown in Fig. 2B.

E. J. M.

FLOATING DEBT, in general, those debts of, or claims against, the government for the payment of which no orderly arrangements have been made. These are set over against funded debts.

Each of the following examples illustrates a class of floating debt of practical importance. Governments have to make payments in advance of the receipt of taxes, especially when the latter come in only once or twice a year. So they issue to claimants, such as officers, teachers, contractors and others, warrants or orders to pay, drawn on the treasury. But if the treasury is empty such warrants cannot be paid at once and so, for the time being, constitute a floating debt. A second example is the issue of exchequer bills or treasury notes. Suppose that claims like those above accumulate in considerable amounts. It is hard on the holders to wait for payment. So the treasurer may be authorized by law to borrow money, supported, of course, by the credit of the government, on short term notes which are to be paid, presumably when the taxes or other funds come in. He then pays off the floating warrants with the money he gets. There are also, always a number of unaudited claims awaiting settlement which constitute a part of the floating debt. Such debts may be evidence of disorderly financial planning, but again may be necessary, as in war, or expedient, in the general management of the public funds.

C. C. P.

FLOATING DOCKS. *See* DOCKS.

FLOATING HEART, the common name for a genus (*Nymphoides*) of handsome perennial aquatic herbs of the GENTIAN family, several of which are grown as water-garden ornamentals. There are about 20 species widely distributed in fresh water in temperate and tropical regions; three species occur in North America. From creeping rootstocks which grow in the mud slender stems rise to the surface of the water bearing heart-shaped leaves and yellow or whitish flowers produced in the leaf axils or sometimes on thread-like stalks.

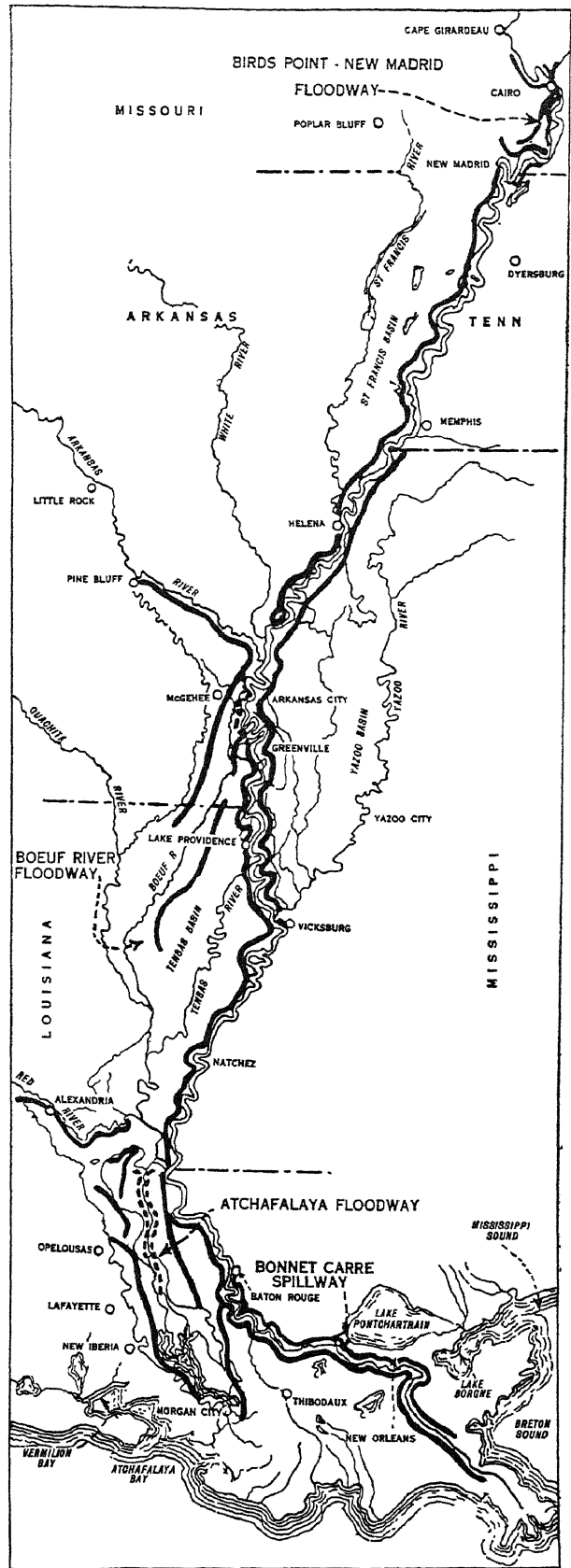
FLOCCULATION. *See* COAGULATION.

FLOCCULI, dark and bright patches on the sun's (See SUN) surface that give it a mottled appearance.

FLODDEN FIELD was the scene of a bloody and important battle fought Sept. 9, 1513, near Branxton, in Northumberland, between a Scotch army of 30,000 under JAMES IV of Scotland and an English army of 32,000 commanded by the Earl of Surrey. In the absence of Henry VIII, who was waging war on the continent, the Scotch King had invaded England, declaring himself an active ally of France. The Scots were grievously defeated; their loss was variously estimated at 6,000-12,000. Their King and many nobles were killed. The English loss was about 4,000. Scott's *Marmion* describes the battle vividly.

FLOE, a mass of floating ice, larger in extent than the average iceberg, but not large enough and generally too shallow to be called "pack ice." It is propelled by the force of the wind.

FLOOD, the breaking of dams, or sea-dykes, or the rush of a tidal wave which inundates inhabited lands



LEVEE AND DIVERSION SYSTEM OF MISSISSIPPI FLOOD PROTECTION

destroying life and property. The most common cause of floods is the rise and overflow of rivers, occurring usually in spring after heavy rainfall or sudden thaws. Seasonal freshets often carry away bridges and cause washouts on roads or railways. When a great river, confined within artificial LEVEES bursts its bounds, a catastrophic flood results.

Certain rivers, notably the Mississippi, the Hwang-ho, the Po, the Ganges, and the Seine, are subject to serious floods. China especially has suffered greatly from flood disasters. In 1911, the overflow of the Yangste Kiang cost 100,000 lives. In 1931, China suffered another disastrous flood.

Among the most notable floods in the United States have been that at Galveston, Texas, in 1900, caused by a West Indian hurricane; the Johnstown, Pa., flood of 1889, resulting from the bursting of a dam and causing the death of 2,000 people; and successive floods in the Mississippi Valley, culminating in the disaster of 1927, which cost 350 lives and a property loss of upwards of \$200,000,000. The extensive felling of forests is in part responsible for floods.

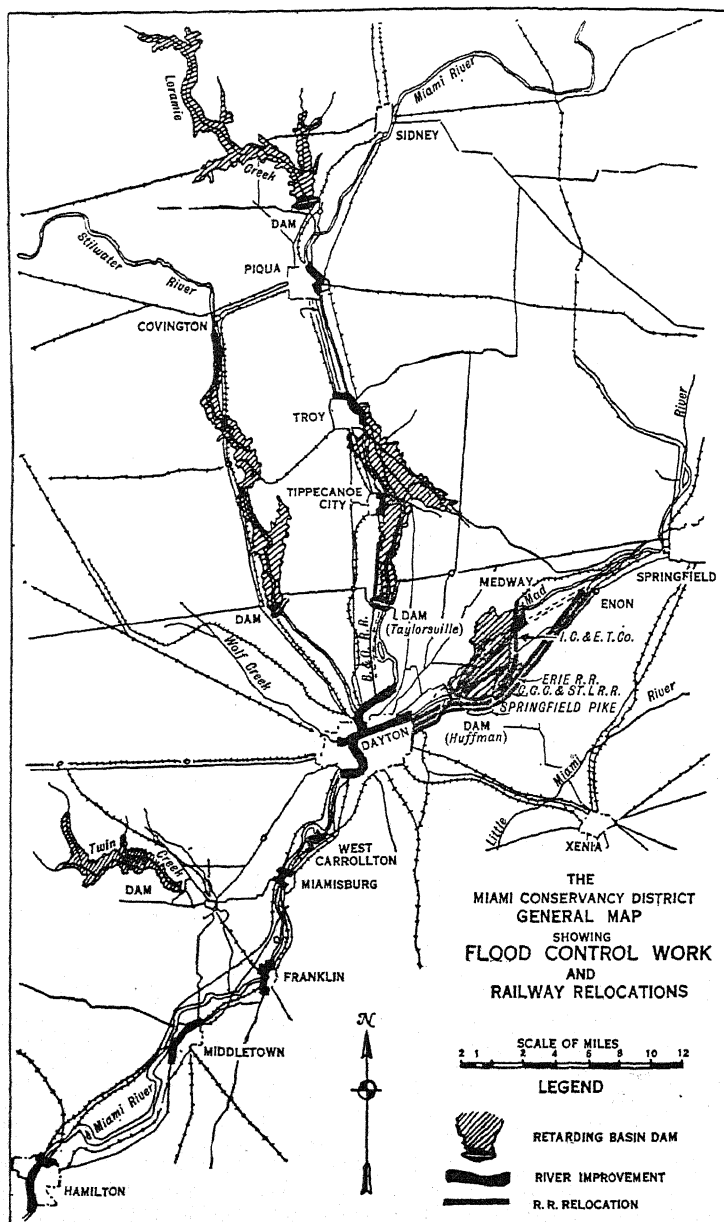
FLOOD CONTROL, preventing the inundation of land, whether by sea, lake or river. Works on the shores of seas are more often designed to break up wave action and are in the form of off-shore breakwaters, sea walls, bulkheads and dikes, although levees to keep out high water are sometimes used, as in parts of Holland. On lakes subject to overflow from any cause, reliance is placed on levees and on controlling the lake level.

The principal flood control works are connected with rivers, where several methods are used: Levees, Reservoirs, Diversions, and Channel Improvements. In alluvial valleys, levees constitute the first line of defense. Reservoirs, used to store or detain flood waters, reduce high water "peaks." They serve as aids in flood control as well as in improvement of navigation conditions, as on the upper Mississippi River; and are a major feature of the flood control works of the Miami, Ohio, Conservancy District. Emergency channels, or floodways, are important details of the new Mississippi flood control plan. Channel straightening, dredging, clearing, and the promotion of scouring, are also used as minor aids. In a major flood control project, the effect of such reforestation as might be practicable would be relatively negligible in comparison with other aids. *See also* RIVER IMPROVEMENT; LEVEES; RESERVOIRS.

F. R. H.

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FLOOD PLAIN, a broad flat along a river inundated in time of flood. The torrential waters of streams in flood transport great quantities of fine mud and silt. In overflow they deposit this sediment, or ALLUVIUM upon the flood plain, forming soil of great



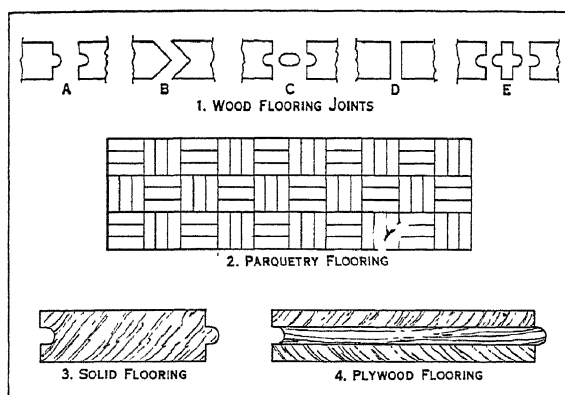
DETENTION RESERVOIR SYSTEM FOR FLOOD PROTECTION OF THE CITIES OF THE MIAMI RIVER VALLEY IN OHIO

fertility, as in the Nile valley. The flood plains of great rivers, including delta lands at their mouths, often support large agricultural populations, and are protected against annual inundation by a system of embankments, called LEVEES. In places the flood plain of the Mississippi reaches a breadth of 80 miles.

FLOOR COVERINGS. Where ordinary service is required carpets are generally used as floor cover-

ings. These are made of wool, silk, cotton, mohair, horse hair and cow hair; paper yarn, jute and hemp sometimes being used as fillers and ramie as backing. A heavy pile on the face side is characteristic of most carpets. (See *PILE FABRIC*.) Floor cloths, which are used in kitchens, hallways and offices, include linoleum, oil-cloth and cork-carpet. Linoleum essentially comprises ground cork and dried linseed oil on a canvas backing; oil-cloth consists of coarse canvas with several coatings of heavy oil paint.

FLOORING, WOOD. Wood flooring is the most extensively used of flooring materials. While not competing in durability with tile, stone or concrete, it is universally used in homes, schools and other



WOOD FLOORING AND TYPES OF JOINTS

A, Tongue and groove. B, "V" joint. C, splined joint. D, square edge. E, "Jed" joint

intimate locations. Solid flooring is made of lumber, tongued and grooved on the edges and ends, in narrow widths to minimize the cracks between boards due to shrinking and swelling. Standard sizes are $\frac{3}{4}$ in. thick by $1\frac{1}{2}$, $2\frac{1}{4}$ and $3\frac{1}{4}$ in. wide. Some flooring is made $\frac{3}{8}$ in. thick for overlaying existing floors. The usual flooring woods are oak, maple, edge-grain Douglas fir and yellow pine. Plank flooring is in random widths, solid or **PLYWOOD**, face nailed and plugged, to reproduce colonial effects. *Parquet* flooring consists of small rectangular blocks and can be arranged in a variety of artistic combinations. Plywood flooring is designed to mechanically counterbalance the shrink, swell, split and warp of solid wood, and can be made in plank and parquetry designs as well as in regular strip patterns. Block flooring (end grain) is also made for factories, garages and other locations subject to heavy wear where the hardness and chill of masonry would be an objection. T. D. P.

FLOOR TRADER, a member of a Stock Exchange who trades in stocks for small, quick profits, who is a professional speculator and has no customers. Floor traders constitute what is known as the professional influence in the market. Such traders by their close contact with the market and their knowledge of its technical position are able to take advantage of the slightest change in prices. Being members of the exchange these traders pay no commissions such as is required of a customer-speculator

trading in a broker's office. The transactions of the floor trader often involve large sums of money. His presence helps to preserve the instant negotiability of the exchange's listed securities.

FLORA, in Roman mythology, goddess of flowers and the spring, also of the flower of youth.

FLORA, the total, individual, constituents of the plants of a region, such as the flora of North America; also a book about them. It comprises the species, genera and family of all the plants of the region, and, as a book, deals with their relationship, distribution, often accompanied with descriptions or illustrations of the species. It differs from vegetation, which comprises the plants *en masse*, such as forests, prairies or the like, while the flora comprises the totality of the individual plant constituents, usually arranged in systematic order. The richness and variety of the flora of different regions vary widely. Some idea of the variation may be gathered from the number of species in flora of the following countries: Greenland, about 400; northeastern United States, 4,079; New Mexico, 2,975; Brazil, over 15,000; Indo-Malaya, over 40,000. N. T.

FLORAL PARK, a village in Nassau Co., a residential suburb of New York City, situated on the western end of Long Island, 15 mi. east of Brooklyn. It is served by the Long Island Railroad. Flower culture is the community's chief industry. The retail business in 1929 was valued at \$5,922,426. Pop. 1920, 2,097; 1930, 10,016.

FLORENCE, a city of northwestern Alabama and county seat of Lauderdale Co., on the Tennessee River, 15 mi. below the Alabama-Tennessee state line. It is one of a "tri-cities" group including Sheffield and Tuscumbia. Transportation facilities include the Louisville and Nashville and the Southern railroads and steamboat connections. The city has grown with the development of Muscle Shoals in the immediate vicinity; the Wilson Dam furnishes water-power for government nitrate plants and the various industries of Florence, including the manufacture of wagons, naval stores and lumber products. In 1929 the manufactures reached approximately \$2,000,000; the retail trade amounted to \$6,090,218. There are rich deposits of iron ore in the surrounding country, which produces substantial crops of cotton and grain. Wilson Lake and Bailey Springs, near by, are resorts. Florence has a State Teachers' College (1873). Founded in 1818, the city was chartered in 1826. Pop. 1920, 10,529; 1930, 11,729.

FLORENCE, a city in Fremont Co., southern Colorado. It is situated on the Arkansas River and the Pikes Peak Ocean-to-Ocean Highway, 35 mi. northwest of Pueblo. There is an airport and bus lines and two railroads serve the city. Farming is carried on in this region and the rich deposits of oil, coal and cement afford material for the local industries. In the 1860's the locality was the second oil-producing region developed in the United States. Florence was incorporated in 1887. Pop. 1920, 2,629; 1930, 2,475.

FLORENCE, a city and the county seat of Florence Co., in eastern South Carolina, situated 113 mi. north of Charleston. Two railroads, bus lines and an airport serve the city. Cotton, corn and tobacco are the chief crops of the vicinity. There are railroad repair shops and wood-working products are manufactured. In 1929 the value of the factory output was about \$2,000,000; the retail trade amounted to \$6,832,104. The Pee Dee Experimental Station is located at Florence and it is the site of a national cemetery. Florence was founded about the middle of the 19th century. Pop. 1920, 10,968; 1930, 14,774.

FLORENCE, a city in north central Italy, capital of a province of that name in Tuscany, and situated on both banks of the Arno, surrounded by ridges of the Apennine Mountains. Its Italian name is *Firenze*. Little is known of the *Florentia* of Etruscan and Roman times. Commercially it became important early in the 13th century, growing until it was the chief city of central Italy and until it was also the foremost intellectual center of all Italy. Its artistic treasures, gathered into a relatively narrow compass, are perhaps the richest in Europe, and of the part played by the city during the Renaissance Arthur Symons says, "Florence is a corridor, through which the beauty and finery of the world have passed."

Florence is particularly rich in fine examples of medieval and Renaissance architecture. In a single one of its squares are clustered three such renowned structures as GIOTTO'S TOWER, the Duomo or Cathedral of Santa Maria del Fiore, and the marble-encrusted Baptistery with its celebrated bronze doors by LORENZO GHIRBERTI and Andrea Pisano. Of its numerous churches, perhaps the best known is the 14th century Franciscan church of Santa Croce, the burial place of MICHELANGELO, and called by Byron "the Westminster Abbey of Italy." The church of San Lorenzo is hardly less famous for its New Sacristy, containing Michelangelo's great tombs of the Medici. Others of note are Santa Maria Novella, with a cloister decorated by GIOTTO; the small but charming Or San Michele; Santa Trinità, with frescoes by Ghirlandaio; and Santa Maria del Carmine, noted for its Brancacci Chapel decorated by Masaccio. The two museums housed in the UFFIZI GALLERY and the PITTI PALACE together contain the world's greatest collection of Italian art. The Botticellis of the Uffizi and the Raphaels of the Pitti are the most celebrated of the paintings, but practically all the Italian masters are represented in one or the other of the two museums. The Uffizi, although much smaller than the Louvre in Paris, is probably the finest art gallery in Europe in point of pure quality. Also noteworthy among the museums are the Academy of Fine Arts, which has Michelangelo's *David*; the Museum of San Marco, with its superb collection of paintings by FRA ANGELICO; and the Bargello, now the National Museum, noted both for its paintings and for its Renaissance marble, ivory and bronze sculptures. Among other well-known structures are the Palazzo Vecchio, the Palazzo Strozzi, the PONTE VECCHIO and the Palazzo

Medici-Riccardi. The city has a university and several libraries, including the Biblioteca Nazionale and the Biblioteca Mediceo-Laurenziana.

Florence does considerable commerce in the agricultural products of the district, but has no important industries. A tourist center, Florence has always attracted the artist and the scholar, as well as the traveler, from other lands. Pop. 1931, 316,286.

HISTORY

Florence, characterized by Dante as "the most beautiful and renowned of the daughters of Rome," was long the capital of Tuscany. It was a Roman colony, located on the Arno, that was doubtless much influenced by its Etruscan environment, especially toward artistic impulses and religious excitability. The little city had a bishop as early as 313, underwent a siege by the Goths in 405, and seems to have been a duchy of the Lombards late in the 6th century. It was a part of the march of Tuscany under the Carolingian emperors and passed to the famous Countess Matilda in 1054. Even then it was securing its trade routes, particularly the one to Pisa, the nearest seaport, putting down the robber barons who had fortresses in the neighborhood, and subduing nearby towns, with whom trade disputes were frequent.

Meanwhile there was much discord within the city between the Guelphs and the Ghibellines. The rich bourgeoisie had become organized into seven greater guilds, or *arti*, each composed of a number of merchant or banking families, with its councils, magistrates, laws and militia. Together the guilds constituted a political group known as the *popolo* with a *capitano*, while another organization, the *commune*, had at its head a representative of the Emperor, the *podesta*, for whom the Bargello palace was built. By 1282 supreme authority was exercised by eight *Priori degli Arti*, an arrangement confirmed by the Ordinance of Justice in 1293 which also provided for the election of a higher official, the *gonfalonieri*.

Great impetus had been given to commerce by the issuance of the florin in 1252, which became accepted as the standard gold coin throughout Europe. At this time, there were probably 80 banking houses in Florence. By the 14th century the city had a population of 100,000, of whom perhaps 30,000 were engaged in manufacturing woolen cloth. Only Palermo, Venice and Paris equalled it in size. The use of Tuscan instead of Latin in the legal documents of the guilds, and by the great Florentine writers, led to the adoption of this dialect as the Italian language.

Civil feuds increased, however, as rapidly as did the wealth and importance of the city. The Guelph party split into two factions, the Neri, or blacks, and the Bianchi, or whites, the latter of whom soon became identified with the Ghibellines. Dante was one of the priori in 1300 but as a partisan of the Bianchi suffered exile shortly afterward, together with the father of Petrarch. The exploitation of the working class led to a revolution in 1378 that was soon suppressed. For the next half century political power

was alternately in the hands of the democratic families of the Alberti and the Ricci or of their aristocratic rivals, the Albizzi. In 1406 Pisa fell under the control of Florence after the most courageous resistance.

In 1434 Cosimo de Medici became the dominating influence in Florence, though remaining ostensibly a private citizen. Thus this family of wealthy merchants and bankers obtained a hold upon the city which they kept for three centuries. Piero succeeded his father in this "boss rule" in 1464, and at his death in 1469 his son, Lorenzo (1449-92), the Magnificent, began to rule with a scarcely veiled despotism under which Florence became the center of Italian culture and the gayest capital in Europe. After the death of Lorenzo, the monk Savonarola, inspired by almost fanatical puritanism, led a reaction in which the French King, Charles VIII, was welcomed by the Republic and the Medici expelled. Savonarola fell a victim to his enemies in 1498; but the democracy struggled on until 1512 when the French were driven from Italy and the Medici restored. It was during this interval of republicanism that Machiavelli was secretary of state. The prestige of the family was increased when in 1513 Giovanni de Medici was elected Pope as Leo X and in 1523, Giulio de Medici, as Clement VII. However in 1527 the family was again expelled from Florence, and only returned after a treaty had been made between the Pope and the Emperor whereby the sovereignty of the city should be vested in Alessandro de Medici, who was married to a natural daughter of Charles V. The Florentines yielded in 1530 only after they had undergone a 10 months' siege in which Michelangelo won great renown as an engineer in its defense. In 1532 the Government became a duchy and in 1569 the Grand Duchy of Tuscany. The rule of the Medici was continued until 1737 when Francis of Lorraine became Grand Duke. Except for a few years under Napoleon, Tuscany was dominated by the Austrian Habsburgs until 1859, when it joined North Italy and became a part of the Kingdom of Italy. Florence was the capital of the new Kingdom of Italy from 1865-71 when Rome became the capital. A. L. L.

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FLORENTINE SCHOOL OF PAINTING, the foremost and longest-lived of the Italian art schools, with a steadily progressive advance for two and a half centuries from the time of Giotto, about 1300, to the death of Michelangelo in 1564. Its full term of life, however, may be said to extend over four centuries, counting its rise with Cimabue, about 1275, to the end of the 17th century with Carlo Dolce.

GIOTTO (1240-1302) almost alone breathed life into Florentine art, quickening dead and conventionalized fresco painting into an expression of natural and spiritual feeling; in his work practically all of the Renaissance methods had their source. Giotto was the first to make figures tri-dimensional, to endow

them with tactile value. For two centuries his methods were carried forward by individual painters, until in the high Renaissance Raphael and Michelangelo had ready to their hands plastic means for their creations, and were unhampered by technical defects. The whole trend of Florentine art was in the direction of figure painting, and those who engaged in it found in Giotto's designs the essentials of line, modeling, perspective, atmosphere and a new use of color.

The Florentine School as a whole was distinctly intellectual, unlike the materialistic VENETIAN SCHOOL. The speculative and scientific spirit prevailed at Florence, with a strong undercurrent of religious mysticism. The greatest artists, such as Leonardo and Michelangelo, were not content to be solely painters. They were architects and engineers; they studied anatomy with the keenness of surgeons, and poetry was part of their means of expression. To the study of oils they carried the same scientific passion they bestowed upon perspective and anatomy. True to temperament, the Florentine coloring was more restrained than the warm Venetian tones. Delicate, pervasive color was as integral a part of the religious, later modified by the classical, subject matter with which they dealt, as the sensuous reddish glow was to Venetian scenes.

The names of the Florentine painters who made lasting contributions to art are too many even to list, but among those whose creative genius added to artistic accomplishment in technique or beauty are Giotto, Orcagna, Masolino, Castagno, UCCELLO, MASACCIO, FILIPPO LIPPI and Filippino Lippi, Roselli, MANTEGNA, Cosimo, Signorelli, BOTTICELLI, Ghirlandajo, Leonardo da Vinci, Fra Bartolommeo, MICHELANGELO and ANDREA DEL SARTO.

FLORES, JUAN JOSÉ (1800-1864), Ecuadorian soldier and statesman, born in Puerto Cabello, Venezuela. At the age of 13, he enlisted in the army, and rose to the rank of general during the war for independence. When Ecuador broke away from Great Colombia in 1830, Flores became its first president, serving until 1834. His policy was reactionary and led to revolts, but, through compromise with his chief opponent, Vicente Rocafuerte, he was re-elected in 1839. He promulgated a new constitution, and was again elected for an eight-year term in 1843, but his opponents drove him into exile in 1845. For the next 15 years he remained in retirement, continually conspiring against the government of Ecuador from without, but returned in 1860 and aided Garcia Moreno to become president. Unable to agree with the new president, he was again forced into retirement.

FLORES. See AZORES.

FLORES, an island of the Dutch East Indies, the largest of a chain that extends from Java to Timor. The island forms part of the residency of Timor and covers an area of nearly 9,000 sq. mi., its length being 224 mi. and its width 40. The surface of Flores is mountainous, with heights reaching from 5,000 to 8,000 ft. above the sea. Hunting, fishing

and agriculture are the main occupations of the people. The chief products are rice, maize, coffee, copra, tobacco, spices and cotton; iron, saltpeter, pumice-stone and brimstone are mined. Laranutka, on the eastern shore, is the capital. Pop. 1920, 433,000.

FLORIAN, ST. (c. 190-230), German martyr and patron saint of Poland, was born at Zeiselmayer, Austria, about 190. Very little is known of his life. In the 8th century his tomb was reported to be at Luchow, where a monastery was built on the site. The taking of his cult to Poland in 1183 by Giles, bishop of Modena, is still commemorated in the great Florian Gate of Cracow and the Church of St. Florian in that city. St. Florian is believed to have been martyred by drowning in the Enns in 230.

FLORIANOPOLIS, a city of Brazil and capital of the state of Santa Catharina, situated on an island about 485 mi. southwest of Rio de Janeiro. The harbor has two fortified entrances. The city has an arsenal, a hospital and several churches. Its trade is restricted because of rough mountain roads and lack of railroad facilities with the interior. German colonists market their agricultural products here. Pop. 1920, 19,574; est. pop. 1930, 46,520.

FLORICULTURE embraces commercial and amateur plant growing in homes, glasshouses or outdoors for ornament. It includes the growing of potted plants and cut flowers and private and public plantings; the latter in some cases impinges upon landscape gardening. From the commercial standpoint floriculture is steadily gaining ground in America, although it is still far behind the leading European countries. As it is intensive rather than extensive in an agricultural sense, the area devoted to it is relatively small; but the capital involved is high on this basis, seventy-five cents to a dollar a square foot of ground covered by glass. As in other branches of horticulture there are specialists, such as growers of roses, carnations, gladioli, orchids, dahlias, sweet peas and other flowers. Each of these has its representative associations, many of which hold annual or more frequent general exhibitions which profoundly influence the vogue of certain flowers, especially of new varieties. See **HORTICULTURE** and the separate articles on the various flowering plants mentioned.

M. G. K.

FLORIDA, the southernmost state of the United States, popularly called the "Everglade State" and also the "Peninsula State." It is situated between 24° 30' and 31° N. lat. and 79° 48' and 87° 38' W. long. On the north it is bounded by Alabama and Georgia, on the east by the Atlantic Ocean, on the south by the Strait of Florida separating it from Cuba and on the west by the Gulf of Mexico and Alabama, being separated from the latter by the Perdido River. Florida comprises an area of 58,666 sq. mi., inclusive of 3,805 sq. mi. of inland water surface. The **FLORIDA KEYS**, extending south and west from Biscayne Bay, are included in the territory of the state. In size Florida ranks twenty-first among the states of the Union.

Surface Features. In Florida the Atlantic and Gulf Coastal Plains unite in a projection extending southward almost to the tropics. This peninsula is a platform of limestone partially and unevenly covered with sand, with a mean elevation of 100 ft. above sea level. The maximum altitude, 325 ft., occurs at Iron Mountain near the center of the state.

Although practically flat, the surface of Florida is diversified by regions having different soil mixtures, each with its distinctive vegetation or surface features. The interior of the main peninsula is crossed by a belt of relatively high sandlands known as the lake region. Here are several thousand lakes of all



FLORIDA STATE SEAL

sizes, some connected by rivers and some with no outlet. The largest include lakes George, Kissimmee and Okeechobee. **ST. JOHNS RIVER**, the principal stream, flows northward along the eastern margin of the lake region and empties into the Atlantic Ocean.

Northern Florida, including the panhandle at the west, is crossed by several rivers, among them the Apalachicola and Suwanee. East of the Suwanee and extending to Tampa, is the lime sink region marked by basins or sink-holes where the underlying limestone has dissolved. Between the lime sink and lake regions is the middle Florida hammock belt characterized by hardwood vegetation. Along the low Atlantic and Gulf coasts are "flatwoods" districts consisting of level, poorly drained sand belts. Their native growth includes long leaf and slash pine with an undergrowth of saw palmettos and wire grass. The southern third of the state comprises the **EVERGLADES**, a region of cypress and mangrove swamps terminating in a coral reef. In addition to its rivers, Florida has an extensive development of underground drainage. In many places the streams emerge from their subterranean channels to form springs. Silver Springs in Marion Co. emerges from a basin 35 ft. deep and forms Silver Springs Run, a crystal-clear stream 50 ft. wide and 9 ft. deep in the center.

Florida has 1,987 miles of shore line. Constant currents off the Atlantic coast have developed a sand spit between which and the mainland is the Indian River extending from Port Orange to Palm Beach. The irregular Gulf coast is fringed with islands and indented by Charlotte Harbor, Tampa, Pensacola and St. Andrews bays.

Climate. Because of its extreme southerly position, great extent of latitude, and proximity to the Atlantic Ocean and the Gulf of Mexico, Florida enjoys a climate varying from warm-temperate to semi-tropical. The mean annual temperature is 70.9° F., ranging from 74.4° F. at Miami on the southeast coast to 69.3° F. at Jacksonville in the northeast.

Miami has an average temperature of 66.5° F. for January and 81.4° F. for August; Jacksonville 55.4° F. for January and 82.1° F. for July. During the period, 1892-1930, the highest temperature recorded in Florida was 107° F. and the lowest, -2° F. Average growing seasons range from 260 days at the north to 365 days in the south. The average annual precipitation is 52.9 in. As in many tropical regions, more rain falls in summer than in winter, an important factor in making Florida a favorite winter resort.

Forests and Parks. Approximately 28,800,000 acres of a total land area of 35,111,000 acres were originally forested chiefly with yellow pines and cypress; oak, red gum, ash and other trees were found in smaller amounts. Chotawhatchee National Forest in the extreme western section of the state and Ocala in the north central section of the peninsula had a total net area in 1930 of 343,180 acres. There is also a federal experimental station at Starke. ROYAL PALM, the only Florida state park, is situated 48 mi. southwest of Miami. It is administered by the State Federation of Women's Clubs and in 1928 comprised 4,000 acres of tropical jungle containing palms 100 ft. in height. Florida has four state monuments of which Olustee and NATURAL BRIDGE commemorate battles of the Civil War. Port St. Joe marks the site of the first constitutional convention held in the state and Dade Memorial commemorates the scene of the Indian massacre of 1835 which opened the Seminole Wars. FORT MARION and FORT MATANZAS are national monuments administered by the War Department.

Minerals and Mining. Florida's mineral resources, so far developed, are of minor importance. With mineral productions in 1929 amounting to \$14,803,606, Florida stood thirty-fifth among the states, ranking first in phosphate rock (75% of the total United States production), and second in fuller's earth. The leading product was phosphate rock, 3,088,298 tons, valued at \$9,901,074. Among other products were limestone, \$1,891,799, clay, \$555,875, and sand and gravel, \$490,381. During 1929 74 mines and quarries gave employment to 3,583 persons who received \$4,138,325 in salaries and wages.

Soil. Alluvial swamp lands in southern and eastern Florida, when sufficiently drained, comprise the richest deposits of the state. In addition, soils, consisting of sandy loams covered by a thin layer of vegetable mold and overlying clay, marl, or calcareous substances are highly productive. These are widely distributed throughout the state. On the uplands, sandy soils occur, which, upon proper cultivation, are well adapted to truck gardening.

Agriculture. The chief crops are fruits, vegetables, grain, cotton and tobacco.

In 1930 5,026,617 ac. or 14.3% of the entire land area was in farms, 58,966 in number, with an average size per farm of 85.2 ac. and an average value per acre of \$84.22. Of the farm area 1,969,234 ac. was crop land; 1,318,585 ac., pasture land; and 1,050,-

995 ac., woodland. The total value of farm property was \$462,456,035, of which \$423,346,262 was represented by land and buildings; \$15,446,476, by implements and machinery; and \$23,663,297, by domestic animals.

According to the census of 1930 Florida produced in 1929 field crops to the value of \$90,345,573, ranking thirty-first among the states. It stood third in all vegetables harvested for sale, first in beans and cucumbers, second in celery, third in watermelons, fifth in tomatoes and eighth in cabbages; it also ranked first in grapefruit and second in oranges and lemons. The chief crops were fruits and nuts, \$46,733,149, and vegetables, \$26,609,957. Other important crops were grains, \$7,333,891, including corn, 6,617,724 bu.; tobacco, 9,248,190 lbs., \$2,885,435; cotton, 34,426 bales, \$2,874,571, and cottonseed, 17,093 tons, \$511,890, and sugar cane for sirup, 1,857,152 gals., \$1,578,579. The leading fruit and nut crops were oranges, 9,720,998 boxes; grapefruit, 5,971,989 boxes; lemons, 32,630 boxes; avocados, 35,220 boxes; strawberries, 12,159,305 qts.; figs, 442,713 lbs.; guavas, 208,632 lbs.; papayas, 192,471 lbs.; pecans, 823,000 lbs., and tung, 111,220 lbs. Among the vegetables were potatoes \$4,885,781, tomatoes \$3,934,253, beans \$3,482,812, celery \$3,436,546, sweet potatoes \$1,886,602, cucumbers \$1,578,970, watermelons \$1,528,065, peppers \$1,491,805, and cabbages \$825,741.

Farm products sold by cooperative marketing rose from \$4,346,379 in 1919 to \$14,369,275 in 1929. Farm machinery and equipment in 1930 included 26,387 automobiles, 12,203 motor trucks, 5,618 tractors, 2,481 electric motors, and 4,502 stationary gas engines.

Animal Industry. Cattle-raising is the chief livestock interest. According to the census of 1930, Florida ranked forty-fourth among the states in total value, \$23,663,279, of domestic animals on farms. Among these were cattle, 431,448, valued at \$12,101,210; mules, 40,916, \$4,338,696; horses, 21,300, \$1,609,112; swine, 567,115, \$3,498,240, and sheep, 47,275, \$181,624.

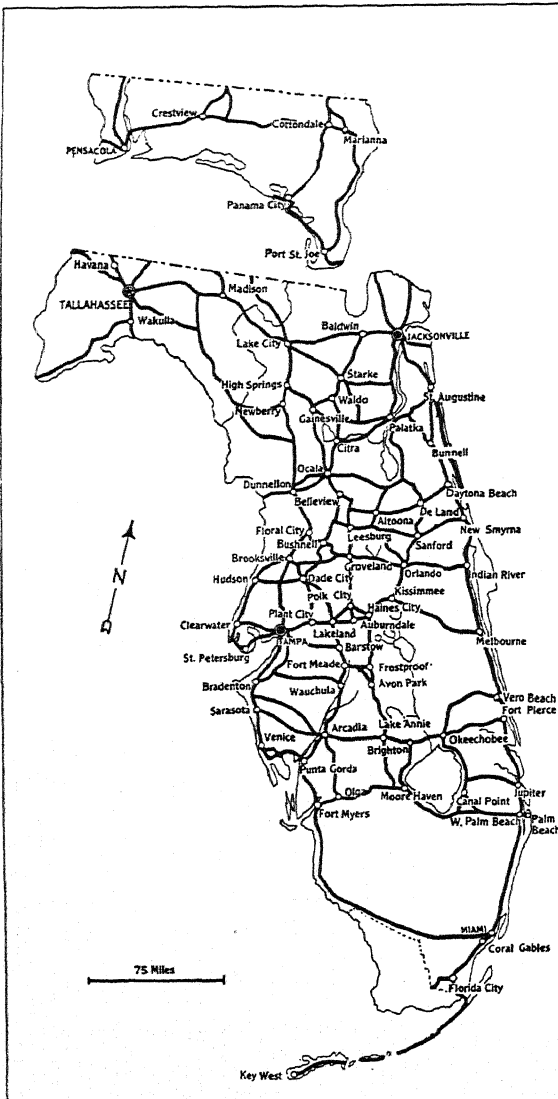
Of the cows on farms, 158,288 were kept mainly for beef production and 88,080 mainly for milk production. In 1929, 26,283,944 gals. of milk were produced; the total value of dairy products sold was \$6,262,589. The value of all poultry raised, chiefly chickens, was \$3,463,629; the chickens sold were valued at \$1,612,230. Of 14,424,168 doz. chicken eggs produced, valued at \$4,831,609, 10,186,301 doz., with a value of \$3,428,193, were marketed. Honey, amounting to 1,333,463 lbs. valued at \$151,355, was produced from 44,168 hives.

Fisheries. In 1930, the state ranked seventh in value of its fisheries, the catch being 145,953,000 lbs., valued at \$6,120,000. The most important species were mullet, shad, red snapper, Spanish mackerel, weakfish and crawfish, terrapin and turtle, and oysters. Florida led the country in the value of sponges and alligator hides.

Tarpon fishing brings sportsmen to Florida from all over the world; swordfish, sailfish, barracuda and

other game fish also are abundant. The state issued 24,602 fishing licenses in 1930 and received \$71,218.30 in fees. Of this amount, \$41,596 went to operate the 7 state hatcheries, employing 12 men. The year's output included 1,444,200 bass, 200,000 other game fish and 103,292,000 crawfish.

Transportation. Florida's position and unusually long coast line assure it of communication by water with Atlantic, Pacific and Gulf coast ports. Its principal ports are Jacksonville, Miami, Key West, Tampa and Pensacola. The Federal Government, with some local aid, has done much to improve the state's harbors and rivers. An inland waterway for light draft



FLORIDA STATE ROADS

boats has been developed between Jacksonville and Miami along the east coast. The drainage canals connecting Lake Okeechobee with the Atlantic Ocean also provide passage for light boats. In 1930 the total railway mileage of the state was 5,686. The principal systems were the Atlantic Coast Line, the Seaboard

Air Line, the Louisville & Nashville and the Florida East Coast. The construction of the latter line is one of the romances of the railway industry; its path across the Florida Keys is a monument to railroad engineering skill.

The state's highway system is improving and extending rapidly. On Jan. 1, 1930, there were 45,306 mi. of highway, including 15,123 mi. of surfaced roads and 3,582 mi. of state highways. The total highway expenditure during 1929 was \$25,519,876, of which \$10,702,163 was paid by the state and \$14,817,713 by county and local governments. Motor vehicle registrations were 327,801 in 1930, compared with 286,388 in 1925. There were 53,096 trucks registered in 1930, as against 48,953 in 1925. During the same period the number of buses in operation increased from 1,134 to 1,671.

Manufactures. The factory industries of Florida have been developed mainly in connection with its forest and mineral resources and the manufacture of tobacco.

According to the Census of 1930 Florida with manufactures for 1929 valued at \$232,386,427 stood thirty-sixth among the states, ranking second in turpentine and rosin, fifth in fertilizers, sixth in cigars and cigarettes, seventh in manufactured ice, and twelfth in lumber and timber products. Its 2,212 establishments gave employment to 6,477 officers and employees, who received \$14,078,356 in salaries, and to 64,868 wage earners, who were paid \$54,582,198 in wages. These factories used a total of 192,695 horse power, expended \$4,821,712 for fuel and power, and \$92,076,528 for materials and supplies, and added by the process of manufacture \$135,488,187 to the value of their output.

In value forest products comprised the largest total, \$53,780,300, including lumber and timber, \$36,912,873, turpentine and rosin, \$11,727,809, and planing mill products, \$5,139,618. Next in value were cigars and cigarettes, \$41,086,735, and fertilizers, \$15,760,243.

The foregoing formed almost one-half of the total manufactures of the state. Other important items in order of value were printing and publishing, \$15,521,005; bread and bakery products, \$10,656,284; steam railway carshop construction and repairs, \$9,186,089; manufactured ice, \$8,745,720, and canning and preserving, \$6,116,663.

The principal manufacturing cities with their output were Jacksonville, \$55,178,183; Tampa, \$53,289,196, and Miami, \$12,423,647.

Commerce. According to the census of 1930, there were in 1929 2,054 wholesaling establishments in Florida, with total sales of \$466,534,961. These organizations gave full-time employment to 20,077 men and women, whose annual salaries aggregated \$26,750,859. The chief wholesaling center is Jacksonville, with Tampa and Miami also important.

The total sales of the 22,411 retail stores amounted to \$497,601,165. Sales per store averaged \$22,203; sales per capita were \$338.92.

CHIEF RETAIL DISTRIBUTING GROUPS

Group	No. of Stores	Sales	% of Total
Food	6,647	\$119,279,804	23.97
Automotive	4,828	111,811,734	22.46
General Mdsc.	2,136	76,369,653	15.36
Apparel	1,366	36,527,396	7.35
Lumber & Bldg.	956	36,149,033	7.26
All other stores	6,478	117,463,545	23.60
Total, all stores ...	22,411	\$497,601,165	100.00

Jacksonville, the principal port, handled a water-borne commerce with a total value of \$186,607,516. Tampa, with a total value of \$99,920,557, and Miami, with \$40,714,020, were also important.

Finance and Banking. The assessed value of all Florida property in 1928 was \$727,821,318. On June 30, 1930 the state had no bonded debt. Total revenue receipts in 1928 were \$26,616,939; total expenditures were \$29,523,960. The chief sources of revenue were the sales tax on gasoline which raised \$9,233,881, motor vehicle taxes, and corporation and franchise taxes. The principal expenditures were for highways, \$13,436,195; permanent improvements, \$13,049,742 and educational aid, \$2,598,152.

There were 203 banks in Florida in 1930, of which 51 were national banks and 152 trust companies and state banks. Their total capitalization was \$25,584,278; their surplus and undivided profits \$17,023,000. Their total resources were \$306,841,000; total loans and discounts \$108,916,000. Demand and time deposits, including postal savings, aggregated \$222,227,000. Per capita demand and time deposits were \$150.15; per capita savings deposits \$50.05. The total savings of \$74,069,000 were owned by 210,268 depositors. National bank circulation aggregated \$4,124,000.

Government. The law-making power is vested in a legislature composed of a senate of 32 members and a house of representatives of 75 members, the former elected for terms of four years and the latter for terms of two years. They meet in biennial sessions limited in duration to 60 days. The chief executor is the governor, elected for a term of four years, but ineligible for re-election; his annual salary is \$6,000. A secretary of state, attorney-general, comptroller, treasurer, superintendent of public instruction and a commissioner of agriculture complete the executive department. Judiciary power is vested in a supreme court of six judges elected for six-year terms at salaries of \$4,500, and also in circuit and county courts and in justices of the peace.

Social Welfare Institutions. There is an industrial school for boys at Marianna and one for girls at Ocala. Gainesville has a farm colony for feeble-minded and Chattahoochee a hospital for the insane. For many years there were no state-owned buildings for convicts, but prisoners were hired out to contractors for their labor. In 1913 a prison farm was established at Raiford where all but the able-bodied Negro men were cared for. These latter were still hired out. In 1923 the lease system was abolished by

law as was also corporal punishment. Raiford is now a state prison for all convicts.

Education. The first schools in Florida, excepting possibly some Spanish mission schools, were the Fellenberg Manual Labor School at Tallahassee and a school at St. Augustine, both founded in 1832. The state public school system dates from 1869. Separate schools are provided for whites and Negroes, and attendance is compulsory for children 8 to 14 years of age for 80 days of the school year. In 1930 there were 275,846 pupils and 7,898 teachers in the 2,103 elementary schools, and 70,588 pupils and 3,062 teachers in the 422 high schools.

The number of persons from 5 to 20 years attending school in 1930 was 304,430, or 66.2% of the population within the ages specified, as compared with 194,845 or 59.7% in 1920. Persons 10 years and over unable to read and write in 1930 numbered 83,242, or 7.1%. Ten years before they numbered 71,811, or 9.6%. Native white illiterates numbered 14,478, or 1.9%, in 1930, and 13,169, or 2.9%, in 1920. Negro illiterates in 1930 numbered 65,167, or 18.8%; and in 1920, 55,639, or 21.5%.

Higher education is provided by the state at the University of Florida at Gainesville and at the State College for Women at Tallahassee. Private institutions include the John B. Stetson University at De Land, Rollins College at Winter Park, Southern College at Lakeland, and for Negroes, the Florida Agricultural and Mechanical College at Tallahassee, the Florida Baptist Academy at Jacksonville and the Normal and Manual Training School at Orange Park.

Population. In 1930 Florida ranked thirty-first among the states with a population of 1,468,211 or an average of 26.8 per square mile, an increase of 499,741 or 51.6% over 1920. The population rose from 34,730 in 1830 to 140,424 in 1860, 528,542 in 1900, 752,619 in 1910 and to 968,470 in 1920. In 1930 1,035,205 or 70.5% were whites and 431,828 or 29.4% Negroes, an increase from 1920 of 61.3% whites and 31.1% Negroes. Of the whites, 976,148 were native born, and 59,057 were foreign born. The urban population was 759,778 or 51.7% of the total, an increase of 403,953 or 113.5% from 1920; the rural population was 708,433 or 48.3% of the total, an increase of 95,788 or 15.6% since 1920. In 1930 the five chief cities were Jacksonville, 129,549; Miami, 110,637; Tampa, 101,161; St. Petersburg, 40,425; Pensacola, 31,579.

Occupations. In 1930 598,939 persons, or 40.8% of the population, were gainful workers 10 years old or older; 75% of these were males and 25% were females; 58% were native white; 5.5% foreign-born white, and 36.4% Negro. Among the chief occupations, with number of workers, were manufacturing, 141,951; agriculture, 133,530; domestic and personal service, 99,748; trade, 79,583; transportation and communication, 47,928; professional service, 37,713; clerical service, 30,926; forest industry, 6,763, and fishing, 6,084.

HISTORY

The name Florida appears on the earliest known map of the New World, the Cantino map of 1502; but Juan Ponce de Leon, the Spanish adventurer who reached the coast somewhat north of St. Augustine on Mar. 27, 1513, and led an expedition inland for a 40 days' march, is the first whose visit is recorded. His attempt in 1521 to plant a colony was unsuccessful. Diego Miruelo evidently sailed along the west coast of Florida in 1516; Vasquez de Allyon, between 1520 and 1526, raided the interior for Indian slaves. Panfilo de Narvaez with 400 men landed at the site of Pensacola in 1528, and thence pushed westward on an ill-fated expedition. Another large company seeking conquest and booty, headed by FERNANDO DE SOTO, reached Tampa Bay in 1539, but suffered as had the preceding Spanish expeditions from Indian hostility. An expedition from Pensacola Bay in 1559 under Don Tristan de Luna also ended disastrously. In 1654 the French entered Florida—Rene de Laudonniere's company of Huguenots, who built Fort Caroline on St. John's River. Almost the whole garrison was slaughtered, in September, 1565, by a military expedition under Pedro Menendez de Aviles sent from Spain to uphold the Spanish claims to Florida. Menendez founded the settlement of St. Augustine, and built several forts at strategic points along the eastern coast. A few scattered missions and fortified posts were the visible results of a century of Spanish domination. Late in the 17th century the encroachments of the Carolina traders and French explorations along the Gulf of Mexico stimulated new activity. Pensacola was founded in 1696. The WAR OF THE SPANISH SUCCESSION was reflected on the seaboard in Carolinian or Georgian expeditions against the Florida settlements in 1702, 1708, 1722, 1740, and 1745, and Spanish expeditions against the English colonies in 1706 and 1742.

Florida was ceded to England in 1763 (*see* PARIS, TREATY OF). The provinces of East and West Florida were created, the latter west of the Apalachicola River, extending to the Mississippi. Civil government now replaced the Spanish military control; indigo plantations, the production of naval stores, and other enterprises were encouraged, and over 25,000 white immigrants settled in Florida within 20 years. A Florida expedition participated in the siege of Savannah (1778). The Spanish seized the English posts in West Florida, and in 1781 captured Pensacola. Florida was retroceded to Spain in 1783, and many of the English settlers withdrew. When the inhabitants of West Florida in 1810 declared the region an independent state and asked for admission to the Union, Pres. Madison accepted jurisdiction. In 1812 part of West Florida was added to the state of Louisiana, and part to Mississippi Territory. Pensacola was garrisoned by the British in the WAR OF 1812, with the consent of the Spanish authorities, who had denied similar privileges to the United States; but Gen. ANDREW JACKSON seized Pensacola in November, 1814. Spanish government became increasingly ineffectual;

Indian bands from Florida raided Georgia settlements, and fugitive slaves, once having escaped into Florida, were beyond recovery. In 1818 Jackson again captured Pensacola. (*See* SEMINOLE WAR.) The United States purchased Florida in 1819 (*see* SPAIN, TREATY WITH), and the vexatious, perhaps unanswerable, question of the exact boundary of Florida was at last removed. Formal possession was taken in 1821, and civil government established in the following year. White emigrants from the southern states soon dominated the territory; on March 3, 1845, Florida was admitted to the Union, paired with Iowa, a free State. One of the CONFEDERATE STATES in the CIVIL WAR, Florida suffered heavily from the extravagances of its RECONSTRUCTION administrations. The state has been consistently Democratic except in the 1928 election, and in 1932 elected Dave Sholtz, Democrat, to the governorship, and reelected Senator Duncan U. Fletcher.

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FLORIDA, UNIVERSITY OF, at Gainesville, Fla., is a state institution founded in 1905 by an act of legislature which provided for the merging of six small state-supported institutions into the University of Florida and the Florida State College for Women. The departments of the university include colleges of Arts and Sciences, Agriculture, Engineering, Law and Pharmacy; Teachers' College; School of Business Administration and Journalism; School of Architecture, Graduate School and General Extension Division. The productive funds in 1931 were \$881,232. The library contains 101,025 volumes. In 1931-32 there was a student enrollment of 2,453, and a faculty of 167 headed by Pres. JOHN J. TIGERT.

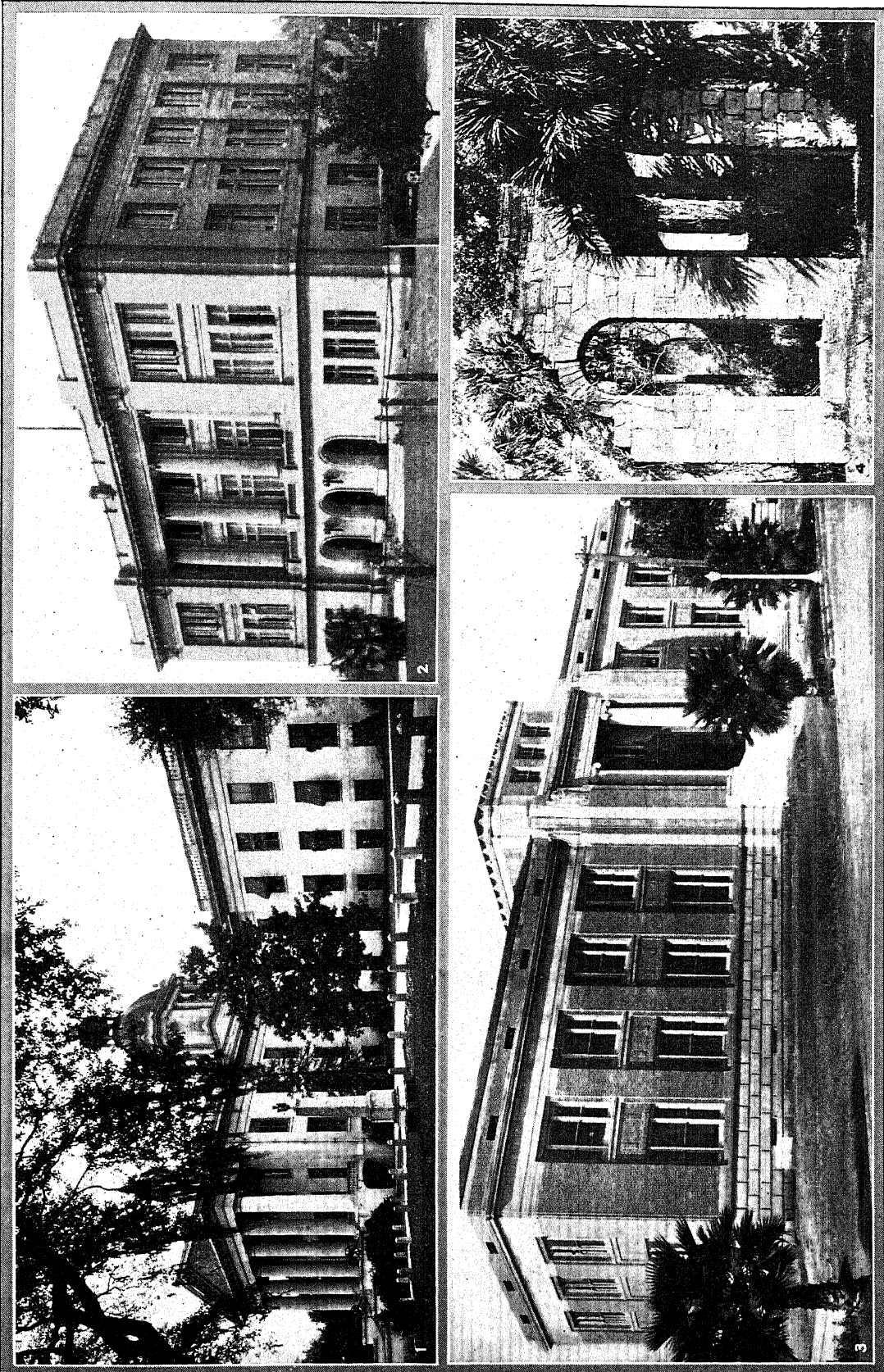
FLORIDA KEYS, a curved chain of small islands extending 140 mi. in a southwesterly direction off the southeastern extremity of Florida. The upper keys, beginning with Soldier and ending with Big Pine, are coral formations covered with tropical vegetation. The lower keys, including the Marqueses and Dry Tortugas, are low limestone elevations frequently swept by hurricanes. A railroad crosses the chain from Largo to KEY WEST.

FLORIDA VELVET BEAN (*Stizolobium Deerlingianum*), a vigorous, twining annual of the pea family of unknown origin but long cultivated in Florida as an ornamental vine. The running stems, sometimes 50 to 100 ft. long, bear leaves of three broad leaflets, clusters of dark purple pealike flowers and densely black hairy pods containing round speckled seeds or beans. The plant is widely grown in the southern states as a winter pasture crop.

FLORIN, a gold coin made in Florence, Italy, in 1252, and at one time widely used in Europe; the name also given to a silver British coin equivalent to two shillings. *See also* GULDEN.

FLORINA, a town in Greek Macedonia, situated at the foot of a lofty range of mountains and connected by rail with Salonika and Monastir. Before 1912 it was a county of the Turkish vilayet of Mon-

FLORIDA



1, 2, 3, COURTESY TALLAHASSEE CHAMBER OF COMMERCE; 4, PHOTO BY VAN DE SANDE

FLORIDA SCENES, MODERN AND HISTORIC

1. The impressive State Capitol at Tallahassee.
2. The Florida Supreme Court building at Tallahassee.
3. The State Office building at the Florida capital.
4. Ruined arch of the Spanish mission erected for the Jororo Indians near New Smyrna, built about 1696.

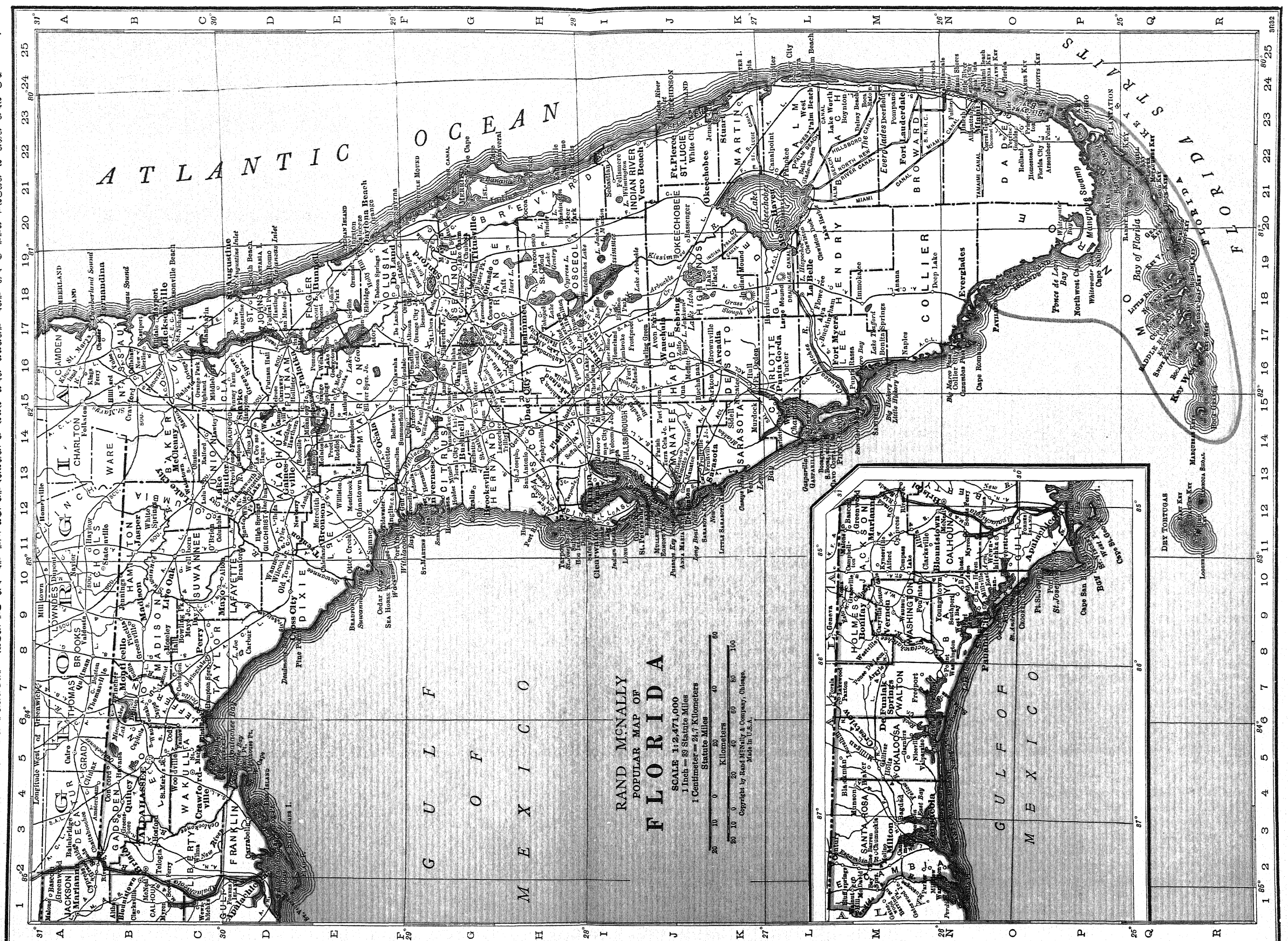
Area 58,666 sq. m.
Pop. 1,468,211

Area 58,666 sq. m.
Pop. 1,468,211

PRINCIPAL CITIES

Pop.—Thousands

- 1 Alton.....C 10
 3 Apalachicola.....D 2, P 17
 1 Apopka.....G 12
 4 Arcadia.....K 16
 2 Auburndale.....H 16
 3 Avon Park.....H 18
 5 Bartow.....I 16
 1 Blountstown.....B 1, N 12
 1 Bowling Green.....J 16
 6 Bradenton.....J 13
 2 Chipley.....M 10
 8 Clearwater.....I 21
 2 Cocoa.....H 12
 6 Coral Gables.....S 23
 2 Dade City.....H 14
 2 Dania.....N 24
 17 Daytona Beach.....E 19
 3 De Funiak Springs.....F 17
 5 De Land.....F 18
 2 Delray Beach.....M 24
 3 Eustis.....F 16
 3 Fernandina.....F 16
 9 Fort Lauderdale.....M 24
 2 Fort Meade.....P 16
 9 Fort Myers.....L 23
 5 Fort Pierce.....J 26
 10 Gainesville.....D 13
 2 Green Cove Springs.....C 16
 3 Haines City.....H 17
 2 Hialeah.....N 23
 2 High Springs.....D 12
 3 Hollywood.....M 23
 2 Homestead.....O 22
 130 Jacksonville.....B 16
 2 Jasper.....B 11
 13 Key West.....R 18
 3 Kissimmee.....H 18
 4 Lake City.....I 15
 2 Lakeland.....I 15
 3 Lake Wales.....I 17
 6 Lake Worth.....L 24
 4 Leesburg.....F 16
 3 Live Oak.....C 11
 2 Madison.....B 19
 3 Manatee.....J 9
 3 Marianna.....M 11
 111 Miami.....N 24
 7 Miami Beach.....O 24
 2 Monticello.....B 7
 2 Mount Dora.....F 17
 2 Mulberry.....I 15
 4 New Smyrna Beach.....F 20
 7 Ocala.....E 14
 2 Okeechobee.....J 21
 27 Orlando.....G 12
 9 Orono.....I 15
 2 Pahokee.....L 22
 7 Palatka.....D 17
 2 Palm Beach.....L 24
 3 Palmetto.....J 13
 5 Panama City.....O 19
 32 Pensacola.....N 3
 2 Perry.....C 15
 7 Plant City.....I 18
 3 Pompano.....M 24
 2 Punta Gorda.....L 15
 4 Quincy.....B 4
 6 River Junction.....B 2, M 12
 12 Saint Augustine.....D 18
 2 Saint Cloud.....H 18
 40 Saint Petersburg.....J 12
 10 Sanford.....G 13
 3 Sarasota.....F 13
 3 Sebring.....N 18
 11 Stuart.....K 23
 2 Tallahassee.....B 5
 101 Tampa.....I 13
 3 Tarpon Springs.....H 12
 2 Titusville.....G 20
 2 Vero Beach.....J 22
 3 Wauchula.....J 16
 27 West Palm Beach.....L 24
 2 Winter Garden.....G 17
 7 Winter Haven.....I 16
 4 Winter Park.....G 16



astir, but during the Balkan War it was occupied by Greece and made the seat of a nomarchy. The city is the market place for the fertile plain which stretches to the north and is the gateway of the highway to Albania, whose frontier is about 20 mi. distant. Pop. 1928, 10,585.

FLORIO, JOHN (1553-1625), English author, was born at London about 1553. He was of a Protestant family from Florence, and acquired fame as a teacher, translator and lexicographer. Under James I, he became tutor to Prince Henry and a gentleman of the Privy Chamber. His popular Italian-English dictionary appeared in 1598; and his translation of Montaigne's essays, one of the best translations ever made, was published from 1601-1603. (See MONTAIGNE, MICHEL DE.) He has been supposed to be the original of Holofernes in Shakespeare's *Love's Labour's Lost*. He died at Fulham, London, in August or September 1625.

FLORISSANT FLORA, late Miocene plant associations reconstructable from the rich fossil-bearing shales of an extinct fresh-water lake at Florissant, Col., not far from Pike's Peak. These paper-thin shales, composed largely of water-laid volcanic ash, preserve exquisitely delicate impressions of thousands of plants anciently flourishing round this forest-girt lake. Since 1873 more fossils, including insects, fishes, birds, and mollusks have been taken from Florissant beds than from any other single locality in the United States. With plants of modern North American types occur a few no longer native, notably three species of aianthus closely related to the Chinese tree now naturalized throughout our eastern states.

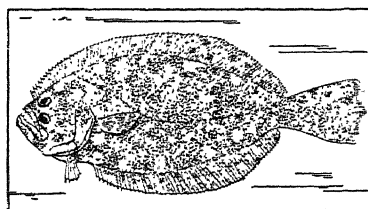
Among plants making up the 250 species of this fossil flora are tufted mosses; a dozen small modern-looking ferns; a single horsetail; pondweeds, cattails, sweet flag; two or three grasses; conifers, including juniper, four pines, and a small forest of sequoias; a dozen oaks, modern-seeming willows, five maples, eight species of ash, seven poplars (one displaying the drooping fruit clusters of cottonwood), a few elms, beeches, hickories and walnuts, seven hollies, beside bittersweet, bayberry, sweet fern, wild roses, grapes, many legumes and single examples each of saxifrage, smartweed, a supposed mallow, monkey-flower, and other herbaceous plants.

FLOTATION PROCESS, a method of ORE concentration in which the ore, first finely crushed, is then agitated in water containing a frothing reagent, usually an oily substance. The sulphide minerals of the ore attach themselves to the air bubbles of the froth which carry them to the surface, while the GANGUE remains in suspension or sinks. The separation of all floatable minerals is known as bulk flotation. By means of selective or differential flotation, a separation of one floatable mineral from another is accomplished; some sulphides float more easily than others, and this difference in floatability is increased by adding appropriate reagents.

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FLOTOW, FRIEDRICH FREIHERR VON (1812-83), German music composer, was born at Teutendorf, Oct. 27, 1812. A nobleman's son, he was educated for diplomacy, but he turned to music upon his arrival in Paris in 1827. After studying with Reicha, he produced several short operas. *Stradella* was given at the Palais-Royal in 1837, and, in revised form, was produced at Hamburg, in 1844. *Martha*, originally a ballet, was given at Vienna in 1847, and by reason of its famous song, *The Last Rose of Summer*, became widely popular. He died at Darmstadt, Jan. 24, 1883.

FLOUNDER, the common name for a group of FLATFISHES, inhabiting shallow bottoms in northern seas, several of which are highly esteemed for food. On the Atlantic coast of North America the most important is the winter flounder (*Pseudopleuronectes americanus*), a small-mouthed species with the eyes on the right side, found from Labrador to Georgia. It usually attains a length of 12 in. and a weight of about a pound. The "filet of sole" served in America is frequently prepared from this species. Highly valued also is the summer flounder (*Paralichthys*



SUMMER FLOUNDER

dentatus), a larger species with the eyes on the left side, found from Cape Cod to South Carolina. It usually attains a length of 1½ to 2 ft. and weighs from 2 to 5 lbs. The starry flounder (*Platichthys stellatus*), the largest of the small-mouthed species, sometimes reaching a weight of 20 lbs., is abundant on the Pacific coast. In 1929 the total catch of flounders in United States waters amounted to 75,329,000 lbs., valued at \$3,479,000. See ANGLING.

FLOUR, the finely-ground product of a grain from which coarse or fibrous particles have been more or less removed by bolting. The term is also used loosely to describe other materials reduced to the same state of subdivision.

Wheat flour is made by cleaning, washing, and scouring WHEAT, then treating with water or steam for some time (tempering) to make the bran tough and elastic, then passing through successive pairs of revolving horizontal steel cylinders or rolls. Between each pair of rolls, the material is sifted to remove the flour formed, and loose particles of germ and bran removed by sifting and aspiration. Thus, the wheat is gradually separated into flour, coarse, gritty particles free from bran and germ, known as *middlings*, and bran and germ with some adhering flour, known as *offal*. The middlings are ground separately to flour.

The quality of the various fractions of flour vary,

that from purified middlings being the best. A combination of all the fractions, sometimes, with the exception of the very poorest, is termed straight-run or straight flour. On the average, about 72 lbs. of straight-run flour are obtained from 100 lbs. of wheat. The rest is offal, sold for feed. Commonly, however, two or more grades are made. The "better" fractions are combined to form patent flour, and the "poorer," to form clear flour.

Wheat flour differs from all others, except rye, in containing gluten, a mixture of two proteins (*see* PROTEINS IN FOODS) which, when wet, becomes tough and elastic and gives to dough its physical character. The elastic dough entraps the carbon dioxide gas bubbles formed in fermentation, giving it a spongy structure that is retained in bread. Other flours merely form a batter with water that lets the bubbles escape and, therefore, produces baked products which are not porous.

Graham flour is made by grinding cleaned wheat, and contains, in their natural proportions, all the constituents of the grain. Whole-wheat flour (*see* WHEAT), or entire-wheat flour, are synonyms for Graham flour.

Bran is the outer coating of the wheat berry obtained as a by-product in milling flour.

Gluten flour is made by doughing wheat flour, removing most of the STARCH by kneading in a stream of water, drying, and grinding. It contains about 40.5% or more of protein and not more than 44% of starch. It is used for low-carbohydrate diets.

Rye flour is made like wheat flour, but is darker and of poorer gluten quality, consequently leavened rye bread is heavier. In America, rye bread is usually made with YEAST from a mixture of wheat and rye flours, but in northern Europe it is usually made from rye flour alone by sour-dough fermentation.

Rice flour is made by grinding broken, polished RICE; much so-called rice flour is merely rice starch.

Potato flour, made by cleaning, slicing, drying, and grinding peeled or unpeeled POTATOES, is principally a stock feed, but is also used in small percentage in bread to impart a special flavor and delay the onset of staleness.

Tapioca flour is the starch of the CASSAVA (manioc) plant, originally from tropical America, but now widely grown through the tropics. The tubers are grated with water, the starch separated by sedimentation, and dried.

Legume flour is the ground product of various dried, ripe legume seeds, most commonly field peas, beans, and soy beans. It is rich in protein.

Peanut flour is made by grinding the cake that remains after expressing the oil from PEANUTS. It is rich in protein of excellent nutritive quality. The nuts are so rich in oil that, unless a considerable proportion is removed, flour cannot be made from them.

For corn flour, *see* CORN MEAL; for millet flour, *see* MILLET; for durra flour, *see also* MILLET. C. L. A.

FLOUR MOTH, MEDITERRANEAN, a small insect of the family *Pyralididae*, probably imported

from Europe. The adults are small, slender, gray moths. The larvæ feed on flour, meal and other ground grains. They are found in kitchens and stores, and particularly destructive in flour mills and injure the flour not only by feeding upon it, but by spinning webs of silk in the material. Several generations occur annually. Control measures consist in fumigation, or in heating the infested buildings to a high temperature.

FLOWER, an important group of organs in plants concerned with reproduction by seeds. Flowers are often striking in color, size, or fragrance. There is a great diversity of form among them and also in the way that they are borne. For any particular plant, however, there is a characteristic arrangement of flower parts and number of parts in a set. These are prevailing three in monocotyledons and five or four in dicotyledons. A complete flower is composed of four sets of parts or floral organs: an outer calyx of green sepals, a corolla of white or colored petals, stamens each consisting of filament and another with pollen-sacs bearing pollen, and a central pistil. The swollen base (ovary) of the pistil, sometimes divided into chambers, contains ovules, and is surmounted by a style (sometimes lacking) with a stigma, a surface receptive of pollen, at its tip. Only the stamens and pistil are essential for a flower, which may be so simple as to produce only one or the other. Corollas when present vary greatly from having separate petals (rose) to those more or less united, or from having petals all alike to those irregular and unlike in form (snapdragon).

Regardless of the arrangement or complexity of the flower, it is with few exceptions (for example the commercial banana, navel orange), concerned with seed production. Pollen is transferred from stamen to stigma by wind (most trees), water, and more commonly by insects. Pollen grains on the stigma develop tubes which penetrate the style and, carrying two male cells, reach the ovules in the ovary. The ovules each contain an egg cell and a small group of nuclei within an embryo sac surrounded by the protective nucellus and integument layers. The pollen tube enters through the micropyle, a pore in the integument. In a process called fertilization, one male cell unites with the egg which then, by successive cell-divisions, makes the embryo plant in the seed. The essential process in fertilization is the fusion of the nuclei of the male cell and egg. The second male cell unites with two other nuclei in the sac, thus initiating the endosperm, a nutritive tissue of the seed. Meanwhile, changes in the integument convert it into the resistant seed coat or testa, while changes in the ovary wall and sometimes adjacent tissues produce the fruit enclosing the seed. Usually, if fertilization does not occur, no seed or fruit are produced and the ovary withers with the other flower parts.

N. E. P.

FLOWER BEETLE, a popular name for various small beetles (family *Scarabæidae*) that feed on pollen. About 60 species are American. The commonest is

the bumble or Indian flower beetle (*Euphoria inda*) which appears in spring and flies near the ground with a humming sound resembling a bumblebee. The second brood which appears in the fall often attacks corn stalks and ears, also ripening fruit. The larvæ of most species feed on decaying wood and fruit, but some are predacious on other insects.

FLOWERING MAPLE, the common name given to various cultivated species of *ABUTILON* with drooping ornamental flowers and leaves resembling those of the maple. See *ABUTILON*.

FLOWERING PLANTS, a group name for all the *ANGIOSPERMS* and *GYMNOSPERMS*, comprising the plants that bear flowers and seeds, as distinguished from the spore-bearing *MOSESSES* and *FERNS*. While flowering plants dominate to-day they are of comparatively recent origin, all their geologically remote ancestors being spore plants. The extreme simplicity of the earliest flowering plants is well illustrated by the *gymnosperms*, where the flower consists only of a naked ovule and pollen usually borne between the scales of a cone. From such simple beginnings has come the development of such complex and completely equipped flowers as are found among the *angiosperms*, notably among the orchids and the aster family. Insect pollination is nearly universal among flowering plants but the *CONIFERS*, all *GRASSES*, and some trees are wind pollinated, and water-borne pollen is common in some aquatic families. See *FLOWER*, *POLLINATION*.

FLOWER-OF-AN-HOUR (*Hibiscus Trionum*), a low, spreading, hairy annual of the *MALLOW* family occasionally cultivated for ornament, native to central Africa and somewhat naturalized in North America. It grows about a foot high, with coarsely toothed or cleft leaves, the upper ones usually 3-lobed, and showy, dark-centered, sulphur yellow or white flowers, 2 to 3 in. across, which close in the shade.

FLOWER PECKERS, the common name for a family (*Dicaeidae*) of very small song birds native to India and Australia. They are only 3 or 4 in. long with handsome, often very brilliantly colored plumage. Active and sociable in habit in small companies, they frequent the higher branches of trees in woods and gardens, feeding upon insects, buds and berries. Their song is a low twittering warble. Some species lay their white eggs in small pear-shaped nests suspended from branches; others deposit their eggs in hollow logs or trees, or holes in the ground.

FLOW IN PIPES. When a liquid flows through a pipe, the velocity, or the amount that passes a given point in unit time depends on the difference of pressure at the ends of the pipe, the *Viscosity* and the *DENSITY* of the liquid and the diameter and general characteristics of the pipe, such as the material of which it is made and the roughness of its interior. Reynolds found experimentally that, in the case of water flowing through a pipe, the flow was streamline up to a certain critical velocity; for velocities above the critical velocity the flow became turbulent, or eddying, in character. Reynolds also found that the

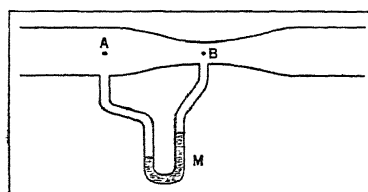
critical velocity can be represented as that velocity in any pipe of diameter, D , for which $\frac{vD\rho}{\mu}$ is equal to about 2,000 when v is the critical velocity, ρ the density of the liquid and the μ the coefficient of viscosity. This number is called *REYNOLDS'S NUMBER*. See also *FLOW METERS*; *FLUIDS*, *FLOW OF*. E. J. M.

FLOW METER, STEAM. See *STEAM FLOW METER*.

FLOW OF FLUIDS. See *FLUIDS*, *FLOW OF*; *AIR FLOW*; *GAS FLOW*; *FLOW IN PIPES*; *AERODYNAMICS*; *HYDRAULICS*; *ORIFICES*, *FLOW THROUGH*.

FLUID METERS, instruments for measuring the volume of flow of a liquid or a gas. Common types are the *VENTURI METER* and the *PITOT TUBE*, which measure the amount of fluid passing a given point in unit time.

If a liquid is allowed to flow in a horizontal tube with converging boundaries, such as is shown in the figure, the character of the flow may be investigated by means of *BERNOULLI'S THEOREM* and a formula set up for measuring the rate of flow. Let a be the area of



a horizontal pipe at A ; b , the area of the constricted portion at B ; d , the density of the liquid; gh , the effective "head," the gravity constant times the height of a given column of liquid; P_a , the pressure at A ; P_b , the pressure at B ; V_a , the velocity at A ; and V_b , the velocity at B . Then, neglecting energy losses between A and B , we may write:

$gh + P_a + \frac{1}{2}dV_a^2 = gh + P_b + \frac{1}{2}dV_b^2$ and $V_a a = V_b b$, since water is practically incompressible. From this we get:

$$P_a - P_b = \frac{V_a^2 d}{2} \left[\left(\frac{a}{b} \right)^2 - 1 \right]$$

$$\text{or } V_a^2 = \frac{2(P_a - P_b)}{d \left[\left(\frac{a}{b} \right)^2 - 1 \right]}$$

But the total volume of the fluid which passes the point, A , in unit time is $V_a a$; hence, *volume* =

$$a \sqrt{\frac{2(P_a - P_b)}{d \left[\left(\frac{a}{b} \right)^2 - 1 \right]}} = k \sqrt{\frac{P_a - P_b}{d}}$$

where k is a constant for any given tube. Thus, by measuring the difference of pressure, $P_a - P_b$, in the manometer, M , the quantity of the liquid flowing can be calculated.

The ratio of the areas, a and b , usually lies between 4 to 1 and 9 to 1, depending on the volume of the flow to be measured.

For a discussion of steam flow measurement, see STEAM FLOWMETERS. For measurement of gas, see GAS METER.

E. J. M.

FLUIDS, FLOW OF. Fluid is a general term applying to all substances which offer little or no resistance to deformation or change of form. Fluids are divided into two classes, liquids and gases. Liquids are practically incompressible and may have a free surface, while gases are readily compressed and fill all parts of the containing vessel. Water is an example of liquid and air of gas.

The equation of Bernoulli (*see* BERNOULLI'S THEOREM) does not apply to gases, because the volume of a gas changes with pressure. However, the effects observed in liquids may be qualitatively produced if a gas is substituted for a flowing liquid. The ordinary atomizer furnishes a familiar example.

If a jet of air is blown vertically upward and a light ball is placed in the path of the jet, the ball will be supported in stable equilibrium. The explanation is that a slight displacement of the ball, say to the right, would cause the main stream to rush to the left and would act as does a constriction in a pipe, causing a reduction of pressure on the left of the ball. The pressure of the atmosphere then forces the ball back again.

If a stream of air is directed between sheets of paper they are drawn together. By the same principle, leaves and other light objects are drawn toward a moving train or automobile. *See also* FLOW IN PIPES; FLUID METERS; AERODYNAMICS; AIR FLOW.

E. J. M.

FLUKES, a class (*Trematoda*) of parasitic flatworms (*Platyhelminthes*). Their bodies are usually flattened, leaf-like or ribbon-shaped. Some are of microscopic size; others are over an inch long. Most of them are equipped with one or several suckers, and often have spines or hooks, with which they cling to the host. The majority are hermaphrodites.

There are two orders of flukes, of which one (*Monogenea*) includes species that are usually external parasites on cold-blooded animals, while the other (*Digenea*) contains forms that, as adults, are always internal parasites of backboned animals. Members of the second order frequently have very complex life histories, which may involve various larval changes, and a period of residence within the body of a back-boneless animal. Certain species, most prevalent in the Far East and South America, cause serious illness to the host. Blood flukes (*Schistosoma*), liver flukes (*Opisthorchis*, *Clonorchis*, *Fasciola*) and the lung fluke (*Paragonimus westermani*) produce diseases in man. *See also* LIVER FLUKE; ANGLING.

FLUME, an open channel used for carrying water for HYDRO-ELECTRIC POWER GENERATION, for IRRIGATION, or for measuring water in conjunction with WEIRS, and for experimental purposes in investigating the action of flowing water. Flumes are made of wood, steel, or reinforced concrete.

FLUORESCCEIN, the anhydride of resorcinphthalic acid ($C_{20}H_{12}O_5$), a coal-tar product used in the production of the valuable eosin dyestuffs. Its sodium

salt, uranin, produces an intense green fluorescence in solution. Fluorescein is not soluble in water and may be precipitated from it as a yellow powder. It may be made by the condensation of phthalic anhydride with resorcinol.

FLUORESCENCE, the emission of LIGHT without sensible heat, and the light so emitted. Some substances, when illuminated with light of certain wave-lengths, absorb that light, and emit the energy at a different WAVE-LENGTH. The rays most effective in producing luminescence in the visible portion of the SPECTRUM are in the ultra-violet region. The most useful principle in this connection is Stokes' Law, according to which the waves given off are always longer than those causing them.

In fluorescence, the emitted light appears only while the primary light is present. But, in some cases, the emitted light continues for a time after the primary light has been cut off, this phenomenon being PHOSPHORESCENCE; LUMINOUS PAINTS are examples of phosphorescent material. There is no essential difference between fluorescence and phosphorescence; in all cases, fluorescence probably persists after the primary light is cut off, though only for a small fraction of a second. Therefore, fluorescence is taken as the generic term applying to both effects.

Fluorescence is now considered as being the result of the lifting of an ELECTRON or electrons to higher energy levels in ATOMS by incident light. In order that this may occur, the light must be of a sufficiently high frequency so that the QUANTUM of energy, $h\nu$, equals, or exceeds, the energy required to lift the electron. The electron will return to its original condition, and, in doing so will give up, as radiation, the energy it received from the incident ray. It may do this very soon, causing fluorescence, or delay the process, causing phosphorescence.

The frequency, ν , of the emitted light will be given by the quantum relation, $E = h\nu$, where E is the energy lost. Since this energy was originally received from a quantum of incident light, the new frequency cannot exceed, and, in general, will be less than, the incident frequency. A single incident frequency may lift different electrons different amounts, so that the fluorescent light may not be confined to a single frequency, but will be a band. Fluorescence bands frequently lie outside the visible region. X-RAYS, which are very short and have a high quantum of energy, cause many substances to fluoresce.

Fluorescence may be caused by bombardment by high-velocity particles, such as electrons in a vacuum. Here the bombarding electrons lift the electrons of the fluorescing material to higher energy levels, and the process of reestablishment takes place as described above.

The phenomenon of fluorescence should not be confused with the greenish-white light given off by PHOSPHORUS in moist air or by decaying tree stumps. These are both chemical changes, and they are irreversible, whereas fluorescence is reversible. Any given substance may be caused to fluoresce repeatedly, for

fluorescence consists simply of the emission by an electron of the energy stored in it by the incident light. P. I. W.

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FLUORIDES, combinations of the element FLUORINE with other elements. Fluorides, which resemble the other HALIDES, tend to form acid salts with HYDROFLUORIC ACID and double salts with other fluorides.

Sodium fluoride is used as an antiseptic, roach poison, and as a flux in enamel manufacture. The fluo-silicates are used as insecticides, detergents, water softeners, and to harden plaster.

Fluorides occur abundantly in nature in the minerals fluorspar (CaF_2) and cryolite (Na_3AlF_6).

FLUORINE, a yellow gaseous chemical element, 1.31 times as heavy as air; symbol F; atomic weight 19; melts at -233°C ., boils at -187°C . It does not occur native but combined, and is twentieth in order of abundance in nature. It is a member of the HALOGEN group; reacts violently with any compound rich in hydrogen and attacks most metals and glass; displaces other halogens from their salts, and is very poisonous. Is prepared by electrolysis of acid potassium fluoride (see FLUORIDES).

FLUORITE, called also fluorspar, translucent to transparent mineral which ranges from colorless to white when pure. Green, violet and purple are common colors, produced probably by organic compounds. It is calcium fluoride, crystallizing in the ORTHORHOMBIC SYSTEM. Fluorite is found crystalline, in earthy, massive and granular forms, and is of common occurrence as GANGUE in veins of zinc, lead, silver, gold, copper and tin ORES.

Fluorite is used as a flux in steel-making, in smelting and in chemical and enameling industries. It is mined in England, France, Germany, and in the States of Illinois and Kentucky. See also ORE DEPOSITS; MINERALOGY.

FLUORSPAR. See FLUORITE.

FLUSHING, Dutch *Vlissingen*, French *Flessingue*, a city in the province of ZEELAND, Holland, situated on the southern side of Walcheren island. Among the churches, the large St. James's of 1328 is the most important. There is a steamship line to Harwich, a pilot station and a sea bathing resort. Shipbuilding and manufacture of machines are its industries. Until 1867 it was a major naval depot, which was improved by Napoleon in 1810-12, after the British had partially destroyed the fortifications in 1809. In 1873-75 the water-front was rebuilt, making the city a commercial port with a wide canal through Middleburg to Veere. It was a flourishing commercial city as late as the 17th century, but later its importance was chiefly as a naval base. Pop. 1930, 21,433.

FLUSHING, a part of Queensborough, in Queens Co., Greater New York. It is situated on the western end of Long Island, on Flushing Bay, 9 mi. northeast of Brooklyn. The Long Island Railroad, bus lines and a subway line serve Flushing. It is essentially a residential community with commercial nurseries and

gardens. English dissenters who probably emigrated here from Vlissingen, Holland, settled the township of Flushing in 1643 and the village in 1644. Flushing became a part of New York City in 1898.

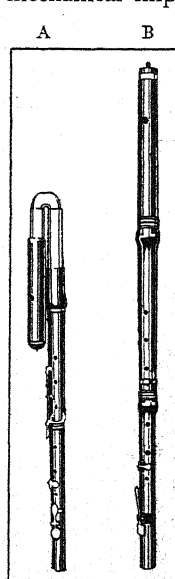
FLUTE, a musical wind instrument of great antiquity, being used by many ancient peoples in its primitive form of a simple wooden pipe equipped with finger-holes. In Greece the flute, called *aulos*, was esteemed especially as an accompanying instrument in vocal music. In its modern form it serves as the soprano part of the wood-wind section of the ORCHESTRA. It is occasionally constructed of ebonite, silver, or even gold, but nevertheless it is always classed with the wood-wind instruments and is commonly fashioned of cocuswood. In its physical aspect the flute is a tube about 26 inches long, equipped with a lateral mouthpiece, or vent, and keys that open and close the openings which were formerly finger holes. Having no reeds, its tone is more limpid than that of the oboe, and is especially sweet and "watery" in the middle register. Thanks to important mechanical improvements made by Theobald Boehm



COURTESY J. C. HOPPIN

FLUTE PLAYER

From a Greek kyllix, or drinking cup, in the Louvre, Paris



COURTESY M. M. OF ART

TRANSVERSE FLUTES

A, Tenor in g; B, Alto in a

in the middle of the 19th century the modern flute is capable of great dexterity in intricate passage-work, yielding to no other wind instrument in flexibility. It has a compass of three octaves, from c' to c''' , that is, from middle C upward, but its tone-color is finest between a' and g'' , having a peculiarly smooth and fluid quality between those terminals.

The piccolo-flute, often called simply the piccolo, is a small-size flute producing tones an octave higher, and shriller, than the flute proper. It is used in the orchestra and military band chiefly to reinforce brilliant passages in the upper register. Being a transposing instrument that produces tones an octave higher than the notes written for it, it has an audible compass from d'' to b''' flat and a written compass from d' to b''' flat. For an explanation of this terminology see OCTAVE.

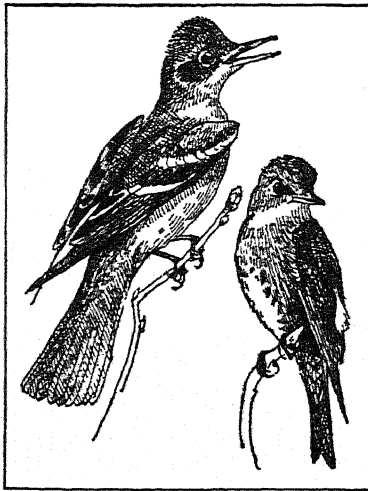
FLUX DENSITY. See MAGNETIC UNITS.

FLY CASTING, the art of fishing on the surface of the water by using a light, flexible rod, weighing from $3\frac{1}{2}$ to 5 ounces, and an artificial fly for bait. The gamiest fish of lake and stream, salmon, trout and bass, are caught on a fly. There are two methods of fly fishing now in use, one with wet- or sunk-flies and the other with dry-flies that float on the surface. The wet-fly, used for large fish, is really a brightly colored bundle of feathers, more closely resembling a

small fish than a fly. Smaller wet-flies are genuine imitations of the flies and insects found on the waters. Further observation of the habits and appearance of these insects has produced the still more natural dry-fly, with upright wings, capable of floating on the water.

It requires practice and skill to be able to place the fly lightly without disturbing the water and to cast long lengths of line. The majority of fishermen use a three-jointed rod from 9 to 10 feet long, though for some lake fishing it is advisable to use a longer and heavier rod. A common practice when wading is to cast across the stream and then allow the fly to float with the current, making it seem alive with occasional gentle pulls from the wrist. The overhand cast is used when there are no obstacles. When the desired amount of line is gradually let out it is whipped back over the shoulder with one movement of the wrist. At an instant, sensed by the fisherman, the rod is cast in the desired direction and the fly placed exactly. Where there are overhanging branches, casts are made by drawing the fly toward the fisherman and sending it out in curved spirals by a downward movement. A more intricate technique is necessary when there is a wind. Experts use a special reel, line and gut leaders for fly casting.

FLYCATCHER, the common name for a large family (*Tyrannidae*) of insectivorous birds found exclusively in the New World and most numerous in the tropics. In size they range from pygmy South American forms less than 3 in. long, to the derby



G. M. SUTTON. "BIRDS OF PENNSYLVANIA"
J. HORACE MCFARLAND CO. COPYRIGHT

FLYCATCHER
Crested, left. Olive-sided, right

flycatchers of Mexico which are nearly a foot in length. Their plumage ranges mostly in shades of olive often marked with yellow or black. Flycatchers are usually solitary in habit and feed on insects. Choosing a favorable perch in a tree, they await hawklike for a long time and then dart away with amazing swiftness to snap up passing insects, usually returning to their original position. All spe-

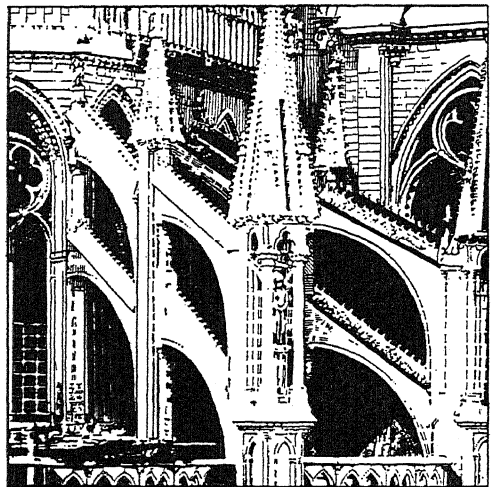
cies are of very great service in destroying injurious insects.

Of about 400 known species some 35 occur in North America, including the great-crested, Acadian, scissor-tailed and least flycatchers, the PHOEBE, wood pewee and the KINGBIRD.

The Old World flycatchers comprise a distinct but unrelated family (Muscicapidae), containing about 700 species somewhat allied to the thrushes.

FLYING BOAT, a heavier-than-air craft with a boat-shaped hull which serves as a landing gear as well as a housing for the crew, passengers and equipment. Many AMPHIBIANS are of the flying-boat type. See also SEAPLANE, AIRPLANE.

FLYING BUTTRESS, a masonry prop or strut designed to carry the thrust of a nave vault over the side aisle to BUTTRESSES on the outer wall; or any element, used decoratively or structurally, of a similar shape. The typical flying buttress takes the form of a half arch with its upper end abutting against the



FLYING BUTTRESSES OF THE APSE OF THE CATHEDRAL
AT REIMS, FRANCE

nave wall and carrying a thin wall of stone with a downward sloping top surface. Sometimes flying buttresses are double, as in Amiens Cathedral; sometimes triple, as in Bourges Cathedral, and sometimes, especially in late Gothic, they are richly ornamented with pierced tracery. Flying buttresses are common in French and German Gothic architecture, and less common in that of Spain and Italy. In England, though they frequently exist, they are often hidden under the side aisle roofs.

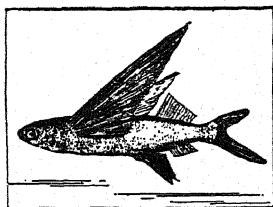
FLYING DUTCHMAN, THE, a haunted ship which, according to an old legend, appears at certain intervals off the Cape of Good Hope, always foreboding misfortune. The *Phantom Ship*, a novel by Captain Marryat, 1836, is based on this legend, as is also Wagner's *Der Fliegende Holländer*.

FLYING DUTCHMAN, THE, an opera in three acts, music and libretto by RICHARD WAGNER; première, Dresden, 1843, London, 1870, Philadelphia,

1876, New York, 1877. Excepting for a juvenile operatic experiment, the work is the second of the Wagnerian music-dramas and a notable advance over the first, *Rienzi*. The score is replete in sombre beauty, expressive of the dark and stormy fate of *Der Fliegende Holländer*, and is premonitory also of the struggles of the gods in the later Wagnerian operas.

A Dutch sea captain, while trying to sail around the Cape of Good Hope in the face of a hurricane, has sworn that he will succeed in the task even if he has to continue sailing forever. Hearing his oath, the Devil condemns him to sail until Judgment Day unless he can find a woman who will love him until death. Once every seven years he may go ashore to seek for the woman who can redeem him; meanwhile he is condemned to sail the seas ceaselessly, a wraith hounded by every hurricane. The foregoing legend comes to the ears of the beautiful Senta, daughter of Daland, a Norwegian captain. It captivates her imagination. She spends many hours gazing upon the picture of the doomed hero of the story. One day, while she is thus engaged, her father brings a stranger into their home on the rugged cliffs of Norway. His resemblance to the picture over which she has brooded is so striking that Senta without delay falls in love with him. She feels that it is her mission to save the man. Eric, a young huntsman in love with her, pleads his own cause with great ardor; and the Flying Dutchman, overhearing these endearments, fancies himself deserted by Senta whom he has grown to love deeply for her own sake, apart from his hope that she will save him from his endless tragedy. In desperation he announces that he is the Flying Dutchman of the legend, and so saying he puts out to sea again. But Senta, undismayed, dashes to the edge of the cliff, and hurls herself into the waters below, faithful unto death. Thus ends the spell which the Devil had cast upon the hero. As the phantom ship sinks, the figures of Senta and the Flying Dutchman are seen clasped in embrace, and mounting heavenward.

FLYING FISH, the name given to fishes capable of rising from the water and proceeding a short distance in the air. The majority of authorities agree that the so-called flight is usually a means of escape from the pursuit of a predatory fish and is caused by a powerful motion of the tail lifting the flying fish into the air, to be sustained there a few seconds by the aid of the large pectoral fins. There are more than



CALIFORNIA FLYING FISH

65 types of flying fish in the family (*Exocoetidae*) all inhabiting warm waters, though sometimes venturing as far north as Newfoundland in summer. They are characterized by slender, scaly bodies from 6 to 18 in. long, pectoral fins almost as long as the body, and a shorter upper lobe on the caudal fin. Many are valued as food fish. A well-known small,

blue and silvery flying-fish (*Exocoetus volitans*) inhabits European and American waters. The California flying-fish (*Cypselurus californicus*) is caught in large numbers off the Santa Barbara Islands. The flying gurnards (*Cephalacanthidae*) also appear to fly, but they are not included among the true flying fishes.

FLYING FOX, a bat of the *Pteropodidae*; fox-bat; rousette; kalong. This is an extensive family of large fruit-eating bats met with from Madagascar eastward to Australasia; very noticeable in Ceylon and Java, where some species have a wing-spread of 5 ft. Usually tailless, they have sharp muzzles, large eyes and pointed ears. The fox-like shape of the head and reddish coat led to the name. These bats assemble in great hordes in trees with ripe fruit, and gorge themselves at night with much noise and turmoil. Some Malayan folks eat them. E. I.

FLYING SQUIRREL. A squirrel which makes prodigious slanting parachute-leaps out of tree-tops. The flying membrane, an extension of the skin of the flanks, is stretched between the fore and hind legs.



FLYING SQUIRREL

The American flying squirrel (*Glaucomys volans*) is an exquisite little creature, with a body about 5 in. long and 4 in. of fluffy tail, large black eyes and fur as soft as chinchilla. Flying squirrels are rarely seen, as they are strictly nocturnal, sleeping by day in hollow trees and coming out to play at twilight.

FLY MUSHROOM (*Amanita muscaria*), called also fly agaric, one of the most deadly of poisonous fungi. It is a strikingly handsome plant, 4 to 8 in. high, with the orange-red or yellow color of the broad cap contrasting strongly with the white wart-like flakes on the surface and with the white stem and gills. The hollow stem, which springs from a bulbous cuplike base, bears a ragged fleshy ring below the cap. The fly mushroom, found very widely in North America and in many other regions, appears in summer or early autumn, growing near trees in woods, groves or along roadsides. The plant contains muscarine, a powerful narcotic alkaloid. Infusions of the plant in milk are sometimes used to kill flies. Fatal cases of MUSHROOM poisoning are caused chiefly by the fly mushroom and the deadly AMANITA.

F.O.B., a commercial term used in connection with the sale of goods to indicate that the price includes all

costs of delivering the goods on board the freight car, ship or other agency which is to transport them to their destination. It is the abbreviated form of free on board. *See also* C.I.F.

FOCAL INFECTION, infection by bacteria localized in some focus, such as the teeth or tonsils. The bacteria or their poisonous by-products are caught in the blood stream and carried to other parts of the body, such as the joints, nerves or muscles, causing infection and inflammation in these parts. The sources of focal infection in the order of their frequency are the teeth, tonsils, intestines (usually the appendix), the nasal sinuses and the genito-urinary tract. The bacteria most often responsible for focal infection are some variety of the streptococcus. The colon bacillus is sometimes responsible.

The symptoms of focal infection cannot be stated in detail as so many different structures may be involved. The condition is usually chronic. The onset of symptoms may be determined by some intercurrent disease, or weakening condition. The general health is usually affected. Fever is rarely present. Anemia and disturbances of nutrition are likely to occur.

The first essential in diagnosis is the recognition of the important part that focal infection plays in the production of various disorders. Chronic ARTHRITIS, or inflammation of the joints, chronic muscular inflammation and similar disorders are not primary conditions. The primary focus of infection from which these disorders arise often has to be searched for, as it may give no symptoms, and examination of many organs may be required. Nor when a focus is found, is it safe to conclude that it is the sole responsible one. There may be multiple foci.

The outlook in cases of focal infection is affected by many factors. If extensive damage has already occurred in certain tissues as the result of infection, removal of the focus cannot produce any alteration in these tissues although it will prevent further damage.

The treatment consists in carefully removing all foci of infection when possible. Vaccines or non-specific protein injections may be helpful. The patient's powers of resistance may be increased by attention to the general health. Fresh air, sunlight, proper diet and treatment for anemia all may be beneficial. *See also* BLINDNESS, MEDICAL ASPECTS OF; TONSILLITIS; VARICOSE VEINS.

W. I. F.

FOCAL LENGTH. *See* PHOTOGRAPHIC OBJECTIVE.

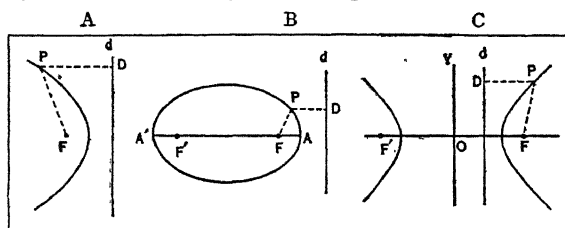
FOCH, FERDINAND (1851-1929), French soldier and commander-in-chief of all Allied forces in the last seven months of the WORLD WAR, was born at Tarbes, Haute-Pyrenees, Oct. 2, 1851. His father was a Government official who gave him a sound education in the humanities, tempered by strict training in religion. Foch attended the elementary schools at Saint Etienne and Metz, and underwent rigorous courses at two Jesuit colleges, where his apparent talent for mathematics caused his father to enter him at the École Polytechnique. He was a few months too

young to engage in the Franco-Prussian War. His chagrin at the French defeat at Metz and Sedan, coupled with his natural bent for geometry and higher mathematics, took him into the army. He received his commission in 1873, and after several years of routine service, entered the École Supérieure de Guerre in 1884, becoming a professor of military operations in 1894. As such he held the rank of major. His lectures became the basis of French military science in the early 20th century, and his two volumes, *Principles of War* and *On the Conduct of War* were translated and widely read. In 1907 Clemenceau appointed him head of the École Supérieure, with the rank of general. Foch made sweeping changes in the curriculum and training system. In 1913 he was placed in command of the 20th corps stationed at Nancy.

On the outbreak of the World War, at the age of 63, he took this corps into Lorraine, where after a severe repulse he was summoned by Joffre to form the new Ninth army in the gap made by the advancing Germans between the Ardennes and the Marne. Foch's reputation as a tactician steadily grew. He checked the Germans at the first Marne battle, stayed the enemy at Ypres, and was an active leader in the Artois offensives and the Somme campaigns of 1915-16. In 1917 he was appointed chief of staff, under Petain. When the German offensive of Mar. 1918 began to crumble the Allied lines, it was apparent to the Entente that only by single command could disaster be averted. The following month Foch was given full authority. In seven months he successively stopped the Germans at Amiens, launched the battles of the Aisne, and designed the counter-offensive from the Meuse to Flanders which forced the Germans to sue for an Armistice. Besides being a marshal of France, he was appointed a British field-marshal after the war, made a member of the French Academy, and served as president of the Inter-Allied Commission. He died at Paris, Mar. 20, 1929.

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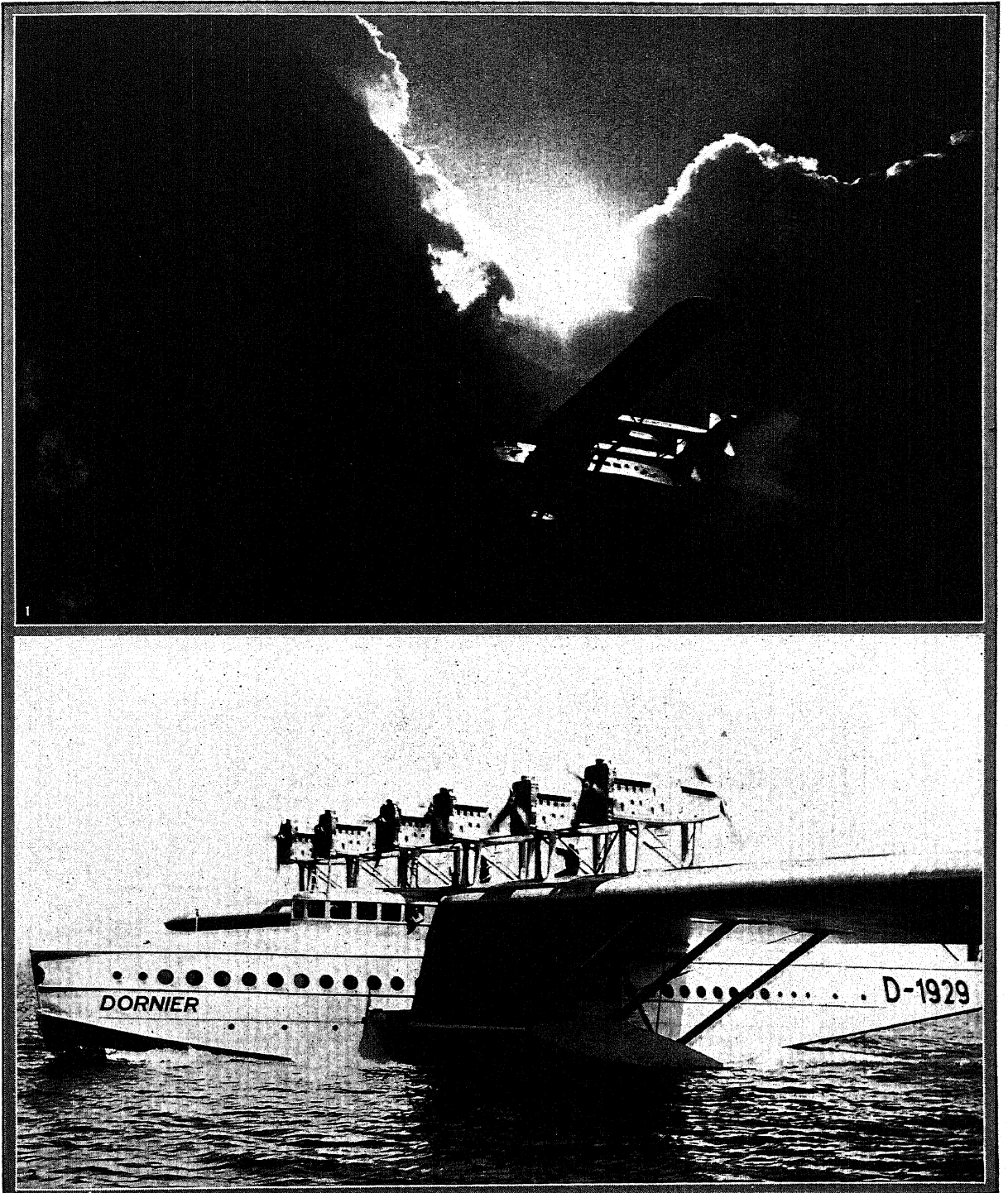
FOCUS, a word originally meaning a fireplace, but generally used at present to refer to a point at which rays, as of heat or light, converge after refraction as



FOCI FOR PARABOLA (A), ELLIPSE (B) AND HYPERBOLA (C)

through a lens, or reflection as from the surface of a parabolic mirror. In geometry it has a similar meaning as in the study of CONICS where the focus of the curve is a point F such that the distance from F to a point P on the curve has a certain ratio to the distance from P to the directrix (d). In the case of the

FLYING BOAT



1, COPYRIGHT R. B. HOIT, FROM R. I. NESBITH AND ASSOCIATES

COMMERCIAL TRANSIT PLANES

1. Sikorsky Pan-American plane, "American Clipper," in South American service. This plane will carry 22 passengers. 2. German flying boat "DO-X," with a passenger ca-

capacity of 166 persons. This ship has three decks and is propelled by twelve 500-horsepower engines arranged in tandem pairs. Its cruising speed is about 130 mi. per hour.

parabola, $\frac{FP}{PD} = 1$; of the ellipse, $\frac{FP}{PD} < 1$; of the hyperbola, $\frac{FP}{PD} > 1$. The ratio $\frac{FP}{PD}$ is called the eccentricity of the conic, and is represented by e . In the case of the ellipse and the hyperbola there are two foci; in the case of the parabola the second focus, F' , is at infinity, and rays perpendicular to d converge at F , a fact made use of in connection with reflecting telescopes, searchlights and automobile head lights. The term is used in connection with other curves. In the case of the ellipse, $F'P + FP = 2a$, the diameter through F' and F .

FOG, a cloud formed by a very fine spray of water drops, slowly moving over the surface of land or sea. Seen from a distance, it would present a distinct boundary and appear no different from any cloud in the sky; it is only that we view it differently being inside it. A fog is produced differently from a cloud, however, in that it does not originate by the simple cooling of air by reduction of pressure, but results from the mixing of two masses of air of different temperature and humidity.

A sea fog occurs because warm air passes over cold water, as in the North Atlantic where the warm air accompanying the Gulf Stream meets the colder waters from the north, or around an iceberg which may then be completely hidden from view. In general, therefore, a sea fog results most frequently in spring and summer when the air is warm and moist. June is the foggiest month in the English Channel, November the least foggy, although it is the foggiest on land. On land a fog may originate on a clear, calm evening, when the air cools rapidly through radiation, and the soil is very moist; it then collects in the lowest places.

A numerical scale has been devised for expressing the visibility in a fog, 0 indicating such great density that nothing is visible at a distance of more than 50 yards, while 9 is almost normal visibility with a limit up to 30 miles. The denser fogs greatly hinder and sometimes even completely suspend traffic on land, especially in cities where the fog is intensified through smoke and dust. They also impart grave dangers to navigation, necessitating slow progress.

Fog is distinguished from *MIST* chiefly in that the latter is a form of rain and is almost invariably less opaque. *HAZE* consists of a cloud of dust or smoke particles and is an entirely different phenomenon. Upon rare occasions a "fog-bow" may be observed, a *RAINBOW* in the fog, about 40° in radius, but *white* in color with at most a reddish outer edge and a bluish inner edge. This white color is due to the small size of the water drops in a fog which causes the rainbow colors to be mixed.

As in the case of dew, regularly occurring seasonal fogs may take the place of rain for agricultural purposes in regions where the actual rainfall is small.

W. J. L.

FOGAZZARO, ANTONIO (1842-1911), Italian novelist and poet, was born at Vicenza, Mar. 25,

1842. After some preliminary poetical romances, he wrote several mystic love stories of renunciation. His genius found able expression in *Piccolo Mondo Antico*, 1895, a historical novel based on the liberation of Lombardy and Venetia. The publication of *Il Santo*, or *The Saint*, in 1906 brought him international fame. Fogazzaro died at Vicenza, Mar. 7, 1911.

FOG BOW, a faint and nearly white rainbow produced by a large number of small droplets of water, as on a bank of fog.

FOGGIA, a city of southeastern Italy, about 20 mi. from the Adriatic, capital of the province of the same name. It is the center of a flourishing district in which increasing areas are being intensively cultivated. The city is almost entirely modern, but there are still remains of the palace of Emperor Frederick II. It is the seat of a bishop and has a park, botanical garden, theater and library. There is a brisk trade in agricultural products, and an annual fair attracts many visitors. Foggia's heyday was in the 13th century, when it was the residence of the Hohenstaufen emperors. It was there that Manfred defeated the papal mercenaries. An earthquake in 1731 destroyed the medieval buildings. Pop. 1931, 57,232.

FOGHT, HAROLD WALDSTEIN (1869-), American educator, was born at Fredrikshall, Norway, Dec. 7, 1869. He graduated from Iowa College in 1897, and pursued his graduate courses at Royal Frederick University, Copenhagen. After teaching in schools and colleges in the Middle West, he was rural education specialist with the United States Bureau of Education, 1912-19. Foght presided over Northern Normal and Industrial School, Aberdeen, S.D., 1919-27, and became president of the Municipal University of Wichita in 1927.

FOG SIGNALS, means of warning ships in a fog of dangerous locations or of possible collisions. They include bells, horns, sirens, wireless fog signals (*see* RADIO) and submarine oscillators (*see* SIGNALING, ELECTRIC). All vessels of U.S. registry, either propelled by machinery or of over 20 tons burden if propelled by sail, must be provided with approved fog signals as well as bells. Whistles, horns and sirens may be actuated by either steam or compressed air. The siren has a cylindrical rotating element turning inside a cylindrical casing. Blades on the periphery of the rotor are revolved rapidly by the escaping air or steam which passes through the openings in the casing, setting up vibrations in the atmosphere that are within the audible limits. *See* SOUND. This sustained sound has great carrying power. Another form of the siren is the Diaphone, where the audible vibrations are produced by a slotted hollow piston vibrating in a slotted cylinder. The Diaphone radiates about 2.36 horse power in the form of sound, although this is only about 6% of the power supplied to it. Measurements of the intensity of the signals could be made at a distance of eight miles.

International rules for preventing collisions at sea provide that in fog, mist, snow or in a heavy rain-storm: 1. All mechanically propelled vessels under

way must sound a prolonged blast from its whistle, siren or horn every two minutes or less; 2. If such a vessel is stopped, it must sound every two minutes two blasts, with an interval between them of one second; 3. A sailing vessel under way on the starboard tack shall sound one blast every minute; when on the port tack, two blasts in succession; with the wind abaft the beam, three blasts in succession; and 4. While at anchor, a vessel shall sound its bell rapidly for five seconds every minute. P. E. S.

FÖHN, a warm and dry southerly wind which blows on the northern slopes of the Alps and alleviates the winter. It is similar in origin to a **CHINOOK**.

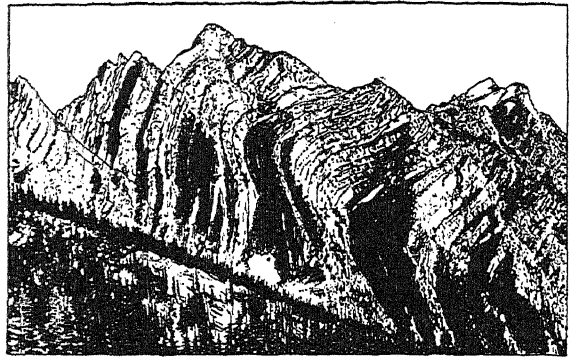
FOKINE, MICHEL (1880-), Russian dancer and one of the developers of the modern ballet, was born at St. Petersburg, Apr. 26, 1880. In 1909 he was appointed choregraphic director of Serge Diaghileff's Russian ballet at St. Petersburg, at which time he adopted the theories of **ISADORA DUNCAN**, and evolved an elastic ballet form. Fokine served as director of the Russian ballet when the company appeared at Covent Garden, London, in June 1911. He composed the ballets for *Le Pavillon d'Armide*, *Le Carnaval*, the opera *Petrouchka* and *Daphnis et Chloe*. In 1920, when he established a school at New York City, he arranged the ballet for the elaborate production of *Mecca* at the Century Theatre. Fokine also designed the ballet for a production of *A Midsummer's Night's Dream* at Drury Lane, London, in 1924. In 1929 he established a ballet school at Hollywood, Cal., and in 1931, at Buenos Aires, staged and produced ballets to Stravinsky's *Fire Bird* and Borodin's *Prince Igor*. See also **DANCE, THE**.

FOKKER, ANTHONY HERMAN GERARD (1890-), Dutch aviator and airplane manufacturer, was born at Kediri, Java, Apr. 6, 1890. In 1912 Fokker built an airplane factory near Berlin and began to supply military planes to Germany. After the close of the World War he established a factory in Holland, then coming to the United States in 1924 to form the Atlantic Aircraft Corporation of which he became the managing engineer, also retaining directorship in the Fokker Works in Holland. He furthered the advance of aeronautics by a succession of improvements in the period 1924-31, notably in body design, and built many of the tri-motored monoplanes widely used as passenger carriers in the United States and Germany, and in the two Byrd polar expeditions.

FOLD, in geology, a deformation or crumpling of the rock-strata of mountainous regions, due to lateral pressure. The long, rolling, billowy skylines of the Jura Mountains, in Switzerland, afford a perfect example of simple, symmetrical folding. The crests are known as *anticlines*, the troughs as *synclines*. Folds may be gently rounded, or peaked. They are sometimes so narrowly compressed that the two sides are almost parallel, or the strata may "fan" out above a pinched base.

When the lateral thrust is unequal on the two sides, the fold leaves the perpendicular and is called

overturned, or it may be tipped over so as to be called recumbent, in which case the strata in the



COURTESY U. S. GEOLOGICAL SURVEY

FOLDED STRATA IN THE ROCKY MOUNTAINS NEAR HEAVEN'S PEAK, MONTANA

under limb become reversed. The slant of the axis of a fold is called its *pitch*. The angle of inclination of its flanks is called the *dip*. Folding is often accompanied by jointing or faulting.

FOLK, JOSEPH WINGATE (1869-1923), American lawyer, was born at Brownsville, Tenn., Oct. 28, 1869. After being graduated from Vanderbilt University, he was admitted to the bar in 1890. While serving as city circuit attorney at St. Louis in 1900-04 he became well known for his vigorous prosecution in cases of bribery. In 1904 he was elected Governor of Missouri. As governor he was responsible for the initiation of much constructive legislation, devoting his attention especially to strengthening the state's anti-trust laws. In 1913 he became solicitor for the Department of State under President Wilson, and in 1914 counsel for the Interstate Commerce Commission. He died at New York City, May 28, 1923.

FOLK-DRAMA, a term designating a type of drama which deals with less sophisticated people usually rural or primitive folk. The protagonists and characters of such dramas are generally depicted as being close to the conditions and processes of nature and lacking in the more cultured refinements of a higher society. The manners, ethics, religious and philosophical ideals of such people are considered to be more nearly derived from and controlled by the ways of the outside physical world (cf. Synge's *Riders to the Sea*) than by the ways and institutions of men in a specialized society (cf. Schnitzler's *Anatol* cycle).

E. K. Chambers and other scholars have held that the old **MORALITIES**, mysteries, miracle and mummer pieces (see **MYSTERY PLAYS**) which involve communal authorship (perhaps) as well as communal production are in the strictest sense folk-dramas. But in the terms of the definition tendered above the word drama is used to mean a conscious art form, and not the haphazard arrangement of individual or group effort. The medieval and pre-Elizabethan pieces are more nearly like the ancient jigs, song-plays, masques, pantomimes, festivals and revels, and bear about the same relation to

true folk-drama as do modern pageants, play-parties, Christmas celebrations and community entertainments.

What determines folk-drama as such, given that it is drama, is neither the point of view of the author nor the community participation in the product, but the folk subject matter; that is, the people who live hard by the ways of nature and not by civilization and its sophisticated arts.

Accepting this definition then, one finds that there have been folk-dramas since the earliest plays of the Greeks; for example, *Agamemnon*, *Prometheus Bound*, *King Lear*, *Rose Bernd*, *Peer Gynt* and *Eyvind of the Hills* as contrasted with, say, *Antigone*, *Hamlet*, *A Doll's House*, *Lonely Lives* and Pirandello's psychologies.

A definite line of demarcation between folk- and sophisticated drama is not always easily determined. But as extremes they can be somewhat demarcated; to instance once more, Ferenc Molnar's *The Guardsman* and S. Ansky's *The Dybbuk*.

Folk-drama as an art expression has only recently been distinguished as such. When in 1846 W. J. Thoms, an Englishman, described the observances, customs, beliefs and prejudices of the common people, he had to invent a term to cover his subject. "Folk-lore" as used by Thoms had of course been observed and noted by many writers, but it was not until well along in the 19th century that the value of folk-lore in the study of the social history of mankind had become apparent to scholars. From Sir Walter Scott's *Minstrelsy of the Scottish Border* to Cecil Sharp's recent work with folk-song, ballad and dance, interest and research in the subject have increased. And today there are so many divisions and ramifications of folk-lore that practically each nation, state and county on the civilized globe has its folk-lore societies, its folk-festivals, its scholars and specialists in folk literature. The folk-arts—handicrafts, instrumental music, song, ballad and dance—have been studied and exploited, and much has been made of folk-drama. But folk-drama is not a folk-art and never has been. Only its subject matter is folk. Both the dramatist and the actors who create the folk-play may in no sense be of "the folk," and their piece may never be seen or heard of by the type of people it portrays, and yet it is folk-drama if its material is such.

The most complete expression of modern folk-drama has come from Ireland. The Irish Literary Renaissance of 25 years ago was a folk-drama renaissance. Led by J. M. Synge, W. B. Yeats and Lady Gregory, a group of young people produced a series of plays of Irish peasant and folk-life at the Abbey Theater in Dublin which made that theater famous the world over. (See IRISH THEATER.) Its influence spread to other countries, being most strongly felt perhaps in America (cf. the work of Frederick H. Koch in North Dakota and North Carolina). Although no country has developed a movement comparable to the Irish one, nearly all modern playwrights have at one time or another written folk-plays. The theory of democracy and the rise of the common man in the last century have no doubt given a new literary value to

peasant and folk-life, and the dramatists have availed themselves of the rich fields of native wisdom and imagination hitherto unexplored. Authors of modern folk-dramas include Johann Sigurjonsson, Iceland; John Masefield and Eden Philpotts, England; Lady Gregory, Brinsley MacNamara, J. M. Synge, and W. B. Yeats, Ireland; Gerhard Hauptmann and Ernst Barlach, Germany; Angel Guimera, Spain; Karl Schönherr, Austria; Knut Hamsun, Norway; Herman Heijermans, Holland; S. Ansky (Shloyme Zalmon Rappaport), Poland; and Eugene O'Neill, Lula Vollmer, Hatcher Hughes and Lynn Riggs, America. The list could be continued at length even to include Tolstoy with his *Power of Darkness*. P. E. G.

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FOLKESTONE, a seaport and watering-place of Kent, England, situated 71 mi. southeast of London. It is built on the chalk cliffs of the Channel coast and sheltered on the north by hills. Indications of Roman occupation are numerous, and from early times, as a member of the Cinque Port of Dover, 5 miles northward, it has been an important port for continental traffic. During the World War it handled thousands of Belgian refugees and American and Canadian troops. On the summit of the cliffs is a grassy promenade, known as the Leas, while old Folkestone below, a picturesque fishing town, shelves down to the harbor. The ancient parish Church of St. Mary and St. Eanswith, also on the cliffs, is largely Early English, the remnant of an early priory founded on the site of a 7th century convent. William Harvey, discoverer of the circulation of the blood, was born in the town, 1578. A deep water pier, 1,480 ft. long, facilitates passenger and general trade traffic. Pop. 1921, 37,535; 1931, 35,890.

FOLK STORY or **FOLK TALE**, a traditional narrative handed down from one generation to another, generally by word of mouth, to explain the origins of life and its circumstances, and to inspire with examples of great heroism and wisdom, or merely to entertain. There is a significant similarity between the folk tales and mythology of entirely different peoples, as in the belief that man and woman were first part of one being—a belief which is held in the Christian religion and also by the Iranians. Tales of heroes are most frequently embodied in BALLADS, and the Iliad and the Odyssey were almost certainly ancient Greek folk tales later welded into single poems. Apart from the folk tales of the American Indians, there are few of American origin, although folk elements appear in Joel Chandler Harris's UNCLE REMUS series.

FOMALHAUT (*Alpha Piscis Austrini*), a star of the first magnitude and the brightest star in the constellation PISCIS AUSTRINUS. It derives its name from the Arabic *Fom-al-Hut*, mouth of the fish. It is white in color, 25 light years distant and 14 times more luminous than the sun. See STAR: map.

FOND DU LAC, a city in southeastern Wisconsin, the county seat of Fond du Lac Co., situated on Lake Winnebago, 18 mi. south of Oshkosh. Bus lines, lake steamers and three railroads serve the city. There is an airport. This region is splendid for dairying and is noted for its Guernsey cattle. Leather and milk products, refrigerators, iron-work and machinery are the chief manufactures of the city. In 1929 the factory output reached the approximate total of \$20,000,000; the retail trade amounted to \$17,274,951. Fond du Lac is the division point of two railroads and has large railroad shops. Around the lake are many attractive summer resorts. A Capuchin monastery is at Calvary, near by. The site was settled about 1836; the city was chartered in 1855. Pop. 1920, 23,427; 1930, 26,449.

FONSECA, GULF OF, an arm of the Pacific Ocean, bounded by Salvador, Honduras and Nicaragua, Central America. It extends inward about 40 mi. and near its mouth, between the volcanoes Conehagua and Casequena, is about 21 mi. wide. The port of Amapala is within it on the island of Tigre. The water of the gulf is nowhere more than 60 ft. deep.

FONT, a vessel in which candidates for baptism are immersed or from which they are sprinkled. As infant baptism did not occur before 200 and but gradually became the prevailing custom, the rite was observed in the cathedrals, which had special baptistries for the purpose. After the bishops had reserved to themselves the rite of confirmation, the presbyters baptized the candidates and fonts were placed in all churches. Originally they were large enough for the immersion of a child, but later they were of stone with a smaller basin and ornamented with symbolical figures or reliefs in connection with baptism, such as the four rivers of Paradise, lions, and the like. Many fonts of this kind from the Romanesque period are still extant. In the 11th century metal basins were placed in the hollowed top of the font, and were later supplemented by metal covers which were also ornamented with Biblical scenes, and raised by chains attached to the ceiling. The finest bronze font, dating from the 13th century, is in the cathedral at Hildesheim. A huge porphyry font was brought over the Alps from Ravenna to the cathedral at Magdeburg in the 10th century. In the late Gothic period baldachins were sometimes placed over the fonts.

FONTAINEBLEAU, a town located in the middle of the forest of that name, about 40 mi. from Paris, celebrated for its palace first built by Francis I and added to and completed by Louis XIII. It was a favorite residence of the kings of France, also of Napoleon. The Revocation of the Edict of Nantes was signed here by Louis XIV in 1685. Pop. 1931, 17,075.

FONTAINEBLEAU, TREATIES OF. Three important treaties in European history bear the name of the famous castle located near Paris in the most beautiful forest of France. The first was signed there

in 1763, towards the end of the SEVEN YEARS' WAR between France and England, during which the neutrality of Portugal had been violated by the English admiral, Boscawen. Portugal had been forced into a war with Spain and had received help from the English. The peace concluded at Fontainebleau resulted in Portugal's fortifying her Spanish frontier and reorganizing her army under English supervision.

In 1785, as a result of Joseph II's attempts to reform the Austrian Netherlands, war between Austria and Holland was averted by the timely intervention of France. Joseph II, in his desire to liberate The Netherlands from the annoyance of Dutch garrisons provided for in the Barrier and Munster treaties, had decided to dismantle the Belgian fortresses and thus make the garrisons unnecessary. He succeeded so readily that he thought he could reopen the Scheldt River to foreign trade, but the Dutch fired on his ships. At Fontainebleau an agreement maintaining the *status quo* was concluded.

Napoleon's plans for making Spain an instrument in his struggle with England matured as early as 1800 when he forced the cession of Louisiana; in 1801, he persuaded Spain to invade Portugal; and in 1803 extorted a subsidy of 6,000,000 francs monthly. Finding, however, that Portugal was exercising her neutrality in favor of England, Napoleon determined to put an end to the peninsular problem by direct control of the territory. To that end, he made Spain sign a treaty at Fontainebleau in 1807, whereby Portugal was to be jointly conquered and partitioned among various satellites of Napoleon, including the Spanish minister, Godoy. The signing was immediately acted upon, Junot marching across Spain and conquering the heart of Portugal before the ink had been dry a month on the treaty of alliance. This conquest was but a preface to the flight of the Portuguese Regent, the forced abdication of the Spanish royal house, the revolt of the Spaniards and appearance of an English army under Wellington as their allies in the Peninsular War which ended only with the English troops' penetration into France in 1814.

J. BA.

FONTANA, DOMENICA (1543-1607), Italian architect, was born in Mili on Lake Como. After completing his education he entered the service of Cardinal Montaldo, afterwards Pope Sixtus V. When Sixtus was elevated to the Papacy, Fontana became his chief architect, building the Vatican Library, the Quirinal Palace and other important edifices. He completed the dome and lantern of St. Peter's, practically following the original plans and details of Michelangelo. The transfer in 1586 of the obelisk, originally carried off by Caligula from Egypt, from its location in the circus of the Vatican to a spot in front of St. Peter's, gave him great though temporary fame. After the death of Sixtus, he was dismissed from his post on the charge of misusing funds of the church. He then went to Naples, and became architect to the viceroy and built the royal palace.

FONTANE, THEODOR (1819-98), German poet, novelist and publicist, was born at Neuruppin, Dec. 30, 1819. He early engaged in literary work and in his 30's visited and wrote upon England. From 1860-70 he was editor of the *Neue Preussische Zeitung*. He was war correspondent in the Danish, Austrian and Franco-Prussian Wars. From 1870-90 as theatrical critic of the Berlin *Vorsische Zeitung*, he exerted a profound influence on the German stage. His novels are realistic pictures of contemporary German life, and include *Stine*, *Effi Briest* and *Der Stechlin*. Fontane died at Berlin, Sept. 20, 1898.

FONTENELLE, BERNARD LE BOUVIER DE (1657-1757), French author, was born at Rouen, Feb. 11, 1657. He was educated by the Jesuits and early gave evidence of a precocious intelligence. He adopted the law as his profession, but on losing his first case, decided to turn to literature. The first proof of really original talent came in 1683, when he published his *Nouveaux Dialogues des Morts*. Interested in astronomy, and with the idea of popularizing it, he published in 1686, *Entretiens sur la Pluralité des Mondes*. The following year he settled in Paris and published a *Histoire des Oracles*, which excited considerable animosity in church circles. In 1691 Fontenelle was elected to the French Academy and in 1697 became perpetual secretary of the Academy of Sciences. He died in Paris on Jan. 9, 1757.

FOOCHOW, a city and port of China, capital of Fukien province, situated 35 mi. from the mouth of the Min River, which is here spanned by a bridge of granite pillars, called by the Chinese "Bridge of Ten Thousand Ages." Foochow is one of the largest cities of China and though since the decline of the tea trade it has lost its position as a trading center of international importance, its coastwise commerce has increased. There are paper and soap factories; and bamboos, matches, fruits and spices are exported. In 1921 the Fukien Christian University was founded at Foochow. Pop. 1929, 338,164.

FOOD, nutritional requirements of the individual. Improper diet insidiously undermines the constitution and paves the way for inefficiency, unhappiness, and often disabling illness. Under the conditions of modern civilization, a diet may be palatable and apparently sustaining yet insufficient in some factor or factors essential to the best health, but if such a diet be continued for a long time it will subtly cause physical deterioration. This has been amply demonstrated in scientific laboratories and confirmed in many instances in human experience.

The dietary essentials are commonly classified as (1) materials yielding energy, drawn from three great chemical groups, namely PROTEINS, FATS and CARBOHYDRATES; (2) materials for construction of the body itself, comprising chiefly proteins and a great variety of mineral elements; (3) materials for the regulation of body processes, including besides water, many minerals and a number of vitamins. (See VITAMINS IN FOODS.) If any dietary essential be lacking, no matter how minute the quantity required, nutritional disas-

ter will ensue in course of time. One of the reasons why white bread spoils the Eskimo diet is because it contains no vitamin C (the preventive of SCURVY). The Eskimo gets most of his vitamin C from raw flesh food. According to Donald Macmillan, a man may consume as much as 15 lbs. of meat in a day, mostly frozen, which is the way meat of northern animals is made palatable and which does not destroy the small amounts of vitamin C in the meat. Now if any considerable part of the meat is replaced by BREAD which contains no vitamin C, the diet may be diluted, so to speak, as regards this vitamin, to the danger point. Since a citizen of New York can get as much vitamin C as he needs for a day from a single small orange, he can eat heated meat (in which vitamin C is destroyed) and white bread (which has none) with safety as regards this vitamin, provided only that he add his daily portion of orange juice. Few foods consist of a single kind of nutrient; most of them are quite complex. But fortunately there are groups of foods which have much nutritionally in common and a classification which will be found helpful in choosing a diet for health and efficiency, includes the following six groups: (1) milk; (2) vegetables and fruits; (3) meat, eggs, cheese and nuts; (4) foods from the cereal grains; (5) fats; (6) sugars and sweets. The outstanding nutritive properties of these foods, along with economic and social factors, determine their place in the diet.

Milk deserves first place, because it (see MILK) contains the most valuable assortment of dietary essentials to be found in any single food material. With milk, it is easy to build a good diet; without it, no diet capable of producing optimum health has been evolved by any people. The form in which milk is taken makes comparatively little difference, so long as none of the nutritive substances are destroyed or discarded. It may be deprived of its water, either in part (evaporated milk) or completely (dried, whole milk) without any diminution in nutritive value. Fresh milk very generally needs to be heated for sanitary reasons. This may destroy whatever vitamin C was in the fresh milk, but the loss of this vitamin can easily be made good by orange or tomato juice since one and a half tablespoons of either yields about as much vitamin C as one pint of fresh milk from pasture fed cows. Such milk is richer in vitamin C than milk from animals given no fresh food.

Milk is the main source of CALCIUM essential in liberal amounts for development of bones and teeth in the unborn infant, the nursing and the child till full maturity, and important for the continued well-being of adults. A quart a day for every child and a pint for each adult makes further search for sources of calcium unnecessary and relieves one of any fear that the diet may be inadequate in this respect. Without milk it is not possible for a child to get as much calcium as he can profitably use for growth, and difficult for an adult to get enough for the maintenance of strong teeth and bones, as well as for important regulatory functions.

Milk is also a rich source of PHOSPHORUS, which must be taken in amounts about equal to calcium, as the two combine to make bones and teeth, and phosphorus is also a very important factor in the structure of every body cell and in the chemical regulation of body processes.

Milk is a fine source of vitamins A, B and G, all essential for growth and needed in very liberal amounts throughout life for the best health. It also contains some vitamin D upon which the utilization of calcium and phosphorus for the construction of strong bones and teeth partly depends.

Milk also contains a high proportion of proteins of the best quality for growth from infancy to maturity. With a quart of milk a day, the adequacy of the diet for any one, child or adult, is practically insured.

Finally, milk is an excellent source of fuel for running the body machine, a quart of milk being equal in fuel value to nine eggs, or one pound of lean beef, or three-quarters of a pound loaf of bread. For such reasons, the wise individual whatever his age or station, will make it his first dietary rule to get a generous daily supply of milk.

Vegetables and Fruits. Vegetables (*see* VEGETABLE) are almost indispensable in the diet as sources of the vitamins needed by mankind in very generous amounts for the highest physical development. Thin green leaves, such as SPINACH, TURNIP tops, WATER CRESS and green LETTUCE are conspicuously rich in vitamin A. They are also more or less rich in vitamins B and G, and if eaten raw, are at the same time excellent sources of vitamin C. Besides green leaves other green parts of plants, e.g. string beans, young peas, and asparagus tips, strongly resemble green leaves in their vitamin content. The coloring matter of CARROTS and TOMATOES is chemically related to the green coloring matter of leaves, and these foods are also rich sources of vitamin A. The tomato, raw or cooked, is also one of our most valuable sources of vitamin C, but cooking or aging destroys much of the vitamin C of the carrot.

Fruits (*see* FRUIT) of the greatest dietary importance are those which contain much vitamin C, and are either very acceptable uncooked (oranges for instance) or else lose little of their vitamin C in ordinary culinary processes, as is the case with the tomato. At the top of the list stand the CITROUS FRUITS and the tomato. Every person should have daily a liberal portion of some food rich in vitamin C. Lack of it quickly results in internal deterioration of the teeth, changes occurring which make them liable to decay. Many times as much vitamin C appears to be needed for a cure of such tooth conditions as would have been necessary for prevention. Every individual should find out what is the most practical source of vitamin C in his locality and plan to incorporate it regularly in his diet. For infants and children a measured portion of orange or tomato juice daily is usually the best safeguard—one to two tablespoonfuls for the infant and from one-quarter to one-

half cup for the young child. At least one orange a day or its equivalent should be included in the diet of older children and all adults.

Both vegetables and fruits contain a variety of mineral elements without which the body is unable to use iron for building the hemoglobin of the BLOOD. Many fruits eaten raw will add to the vitamin C in the daily portion of orange or tomato juice. They also (whether raw or cooked) furnish minerals important for keeping the blood in prime condition. One raw fruit and one cooked fruit daily is a good rule.

Meat, Eggs, Cheese and Nuts. Meats (including fish, fowl and game) constitute a group of foods rich in protein, one form of building material needed in rather large amount as compared with requirements for the different mineral elements as building material. Protein is unique in being also a good body fuel, and so used when not needed for constructive building purposes. Meat (*see* MEAT) in the American diet means usually cooked muscle tissue whatever the animal from which it is derived. It is high in protein, phosphorus, iron and vitamin G with a little vitamin B, but lacks calcium and vitamins A and C. It is not, therefore, a substitute for milk or fruits and vegetables, and should never be allowed to displace these foods. The habit of eating milk, vegetables and fruits, the "protective foods" of the diet, should be well established in the case of every child before meat is added. In proportion to its nutritive value, meat is usually very expensive and care should be taken that money is not spent for it until suitable amounts of milk, fruits and vegetables are provided.

Liver and kidney resemble milk in being rich in vitamins A, B and G, but like other meats, are lacking in calcium and hence cannot take the place of milk, but may be added as supplements to it, especially for iron.

Eggs (*see* EGGS) are very rich in the vitamins A, B and G, and in iron, and contain some calcium in which meats are so conspicuously deficient. The yolk is the part in which these important nutrients are found. The white has little but protein to commend it. For growing children an egg a day is very desirable, but if both eggs and milk cannot be bought, it is better to spend the money on milk and supplement it with green vegetables, trying to get an egg two or three times a week.

Cheese (*see* CHEESES) made from milk, is rich in protein, vitamin G, calcium and phosphorus. If the milk fat is retained, it is also rich in vitamin A. It should not displace whole milk in the diet of children, but is an admirable substitute for meat, if given in forms easy to digest.

Nuts contain protein of excellent quality, along with much fat. When very finely ground they are easily digested, and may be used to add to the variety even of children's diets. They may be regarded as good substitutes for meat, but not for eggs or cheese.

Foods from cereal grains help to make the diet economical. For most people this is exceedingly

important either because of difficulty in getting enough money to buy adequate food or because of a desire to save as much as possible on food in order to have more money for other needs. Cereal grains (*see* CEREALS) furnish over one-fourth and not infrequently as much as one-half of the total energy value of most diets in this country and Europe. *See* FOOD SUPPLY OF THE WORLD.

To many people fine white bread (*see* BREAD) represents man's supreme achievement in the use of cereal grains, and that it is an achievement no one would deny. But nutritionally such bread represents fuel for the machine and little else. One can work on bread, but one cannot keep the human machine in prime condition unless building and regulating materials are also generously provided any more than an automobile can run with plenty of gasoline and no oil. A child that has every day a quart of milk, an orange (or its equivalent in tomato), a cupful of a cooked leafy vegetable, one or two servings of other vegetables and one or two other servings of fruit, an egg, and some butter, can safely satisfy further demands of his appetite with white bread. But a child whose diet is restricted to a few foods for economy's sake is in danger of undernutrition unless every penny is spent to the best advantage. Such a child should have a large part of his cereal food in the form of products which represent the whole grain, because at little or no extra cost he will get from these iron in a form very readily utilized while the BRAN and germ will both furnish much vitamin B, so necessary to good appetite, good digestion and good absorption.

Fats add to the palatability of the diet, help to create interest by adding to the variety of ways in which foods can be served, and give a feeling of satisfaction for a considerable time after a meal. But they are primarily fuel foods rather than building and regulating foods. Milk fat (cream or butter) is an exception, being rich in vitamin A with some vitamin D as already stated. Where circumstances permit, it may well be given preference on this account over other animal fats or seed oils. The fat richest in vitamin A and superior to any other known food as a source of vitamin D is COD LIVER OIL. It is now generally the custom to give babies and young children a daily portion of this oil. Many adults have also perceived the advantage of this habit and adopted it themselves, increasing their resistance to certain types of infection, including colds, improving the condition of their gums and adding to their general vigor and health.

Sugar contributes no body building or regulating material, and if used freely tends to blunt the appetite for essential foods, like milk and vegetables, as well as to make the diet less valuable for health and growth. In the diet of the growing child it has no place except to increase the palatability of certain foods which are rather tasteless without a little sweetening. For active youths whose energy expenditure is very high it may be a desirable form of extra fuel to take at the end of a meal, after the more important

foods have all been consumed. A good rule is one teaspoonful of sugar a day for the pre-school child, one tablespoonful for the elementary school child, and not over three or four tablespoonfuls for any high school boy or girl. This sugar should be used in such ways as to make acceptable the really important foods, milk, vegetables and fruits. For older men and women who need to reduce rather than add to their energy intake, it should be rigidly excluded. The more the calories are reduced, the more important milk, fruits and vegetables and eggs become and the less place there is for sugar.

See also DIET AND DIETETICS; INVALID FOODS; IRRADIATED FOODS. M. S. R.

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FOOD, MINERAL ELEMENTS IN. There are at least 15 chemical elements known to be essential to the development and normal functioning of the human body. These are carbon, hydrogen, oxygen, nitrogen, sulphur, phosphorus, calcium, iron, sodium, chlorine, potassium, magnesium, manganese, iodine, copper. The same elements are found in plant and animal tissues used as food, and these, together with drinking water, are used by the body as its source of supply to replenish the elements lost in the constant disintegration of body tissue. Others, including fluorine, silicon, zinc, aluminum and arsenic have been found in the body in minute quantities, but whether they are necessary constituents of the diet is not yet known.

Of these substances, carbon, hydrogen, oxygen and nitrogen are furnished by proteins, and carbon, hydrogen and oxygen by fats and carbohydrates also. Sulphur exists in varying amounts in almost all proteins, as a part of the amino-acids cysteine and cystine. Phosphorus and iron are also found in combination with a few proteins and phosphorus is present in the important fat-like substance lecithin and in certain phosphorus-containing carbohydrates found in cereals.

The remaining elements are supplied in inorganic compounds in food and in water. Some phosphorus is found in the form of inorganic salts in whole grain cereals, vegetables and fruits. These inorganic substances are frequently spoken of as ash constituents, because they remain in the ash when the organic materials in the food (proteins, fats, carbohydrates and organic acids) are burned in the air; they are also called mineral salts, because it is in this form that they are excreted as end-products of metabolism.

Most of the calcium in the diet comes from MILK and CHEESE, for milk is the richest food source of calcium. Indeed, it is almost impossible to plan a practical and economical diet which will meet the body's need for calcium without depending mainly upon milk. Next in importance to milk come vegetables, which vary greatly in their calcium content. Eggs, fruits and whole grains contain some, but refined cereals have very little. Meat, fish and poultry are exceptionally poor in calcium. Pure fats and sugars contain no minerals of any kind.

Sodium and chlorine are constituents of almost all foods, and, in addition, are used in sufficient quantities as a condiment, in the form of common salt, to more than meet nutritional needs. Magnesium, potassium and manganese are widely distributed among foods. Vegetables and milk are particularly rich sources.

Iron occurs in food almost entirely in organic form as a part of certain proteins. The most important sources are liver, kidney, lean muscle meat, eggs, leaf vegetables, fruits and whole grain cereals. Milk is very poor in iron. Alone it could not supply enough to prevent ANEMIA, but what is present is very readily absorbed and assimilated.

The importance of copper and iodine in nutrition has been recognized only recently. Copper is rather widely distributed, being found especially in vegetables, meats, eggs and whole grains. Iodine comes largely from sea water. It is, therefore, found in greatest quantity in sea foods. There is also some in water which comes from soil near the sea-coast or derived from certain rocks, and in fruits and vegetables grown in such soil. Fresh water fish and foods grown in some inland regions contain very little iodine.

Minerals play a double rôle in nutrition. They are essential constituents of tissues of various kinds, including bones and teeth, muscles, glands, blood corpuscles, brain and nerves, and are found dissolved in the blood, lymph, digestive juices and other body fluids. They regulate body processes, such as maintaining the neutrality of the blood, giving to the digestive juices their characteristic acidity or alkalinity, influencing the ability of muscles and nerves to respond to impulses, controlling the osmotic pressure and solvent power of all the body fluids, and in other ways making all parts of the body function normally. *See also* NUTRITION. H. T. B.

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FOOD ADULTERATION, the act of debasing foods offered for sale by adding to them some worthless substance or by taking from them some of their valuable constituents. Adulterants fall into the following classes: Those which directly menace the health of the consumer, including poisons, such as arsenic from improperly sprayed fruits and certain forms of bacterial decomposition, such as botulinus toxin; those that are offensive, such as worms or decomposed and filthy materials; those which involve economic cheat, such as excessive moisture, false weights, and fillers; and adulterations, which may also be perpetrated by misbranding.

Seizures and prosecutions in the first two classes are relatively rare today. The third class still provides occasion for enforcement activity but is one of the situations which have been greatly improved by the cooperation of the honest manufacturers, while the fourth class is increasing.

The food manufacturer is using this new scientific

knowledge of foods to strengthen his consumer appeal. Up to a certain point his efforts are educative, beyond that point they become a menace. And this menace lies not so much in what his label or collateral literature says as in what it implies.

No one objects to dissemination of facts about diet, none object to honest statement of food values. But because Smith's product contains vitamin A and vitamin A is helpful in resisting infections such as colds it does not follow that the only way to prevent a cold is to eat Smith's cereal. This is the type of abuse in selling claims that is increasing.

Caveat emptor (let the buyer beware) has been superseded as a principle of marketing by advertising and labelling as a means of educating the consumer, and persons are less liable today to become ill from eating poisoned foods than they are to be fooled as to the necessity of a purchase through subtle misbranding. The Pure Food Law has materially reduced health menace from innocent purchase. W. H. E.

FOOD AND DRUGS ACT, NATIONAL. *See* PATENT MEDICINES.

FOOD HYPERSENSITIVENESS. *See* ALLERGY; FOOD POISONING.

FOOD POISONING. Insufficient food, unbalanced diets, overconsumption, improper storage, and understerilization equally influence our morbidity and mortality by producing on one hand lowered vitality and inability readily to resist disease, and on the other hand definite intoxications, poisonings and infections.

Food poisoning in general must have been with us always. We can recall our ancient history of the food taster to the king. It may be expedient to recall that the act of tasting food has been the cause of several deaths from botulism to housewives, presumably in testing its safety. From the early reports one sees a definite idea that food poisoning was regarded as entirely chemical in nature. Admitting that harmful chemical substances may produce symptoms analogous to those considered typical of food poisoning, in the light of our knowledge of to-day, it is most probable that all outbreaks are bacterial in character or the result of bacterial metabolism.

Briefly, food acts as a poison in the following manner: (a) poisonous in itself, such as the so-called mushroom poisoning; (b) because of growth of organisms with which it has been contaminated, either in nature or in its preparation (*B. botulinus*, paratyphoid group); (c) because the food may originate in a dangerous source (animal parasitic diseases, anthrax, tuberculosis); (d) idiosyncrasies (various people are hypersensitive to certain foods and this manifests itself by rashes on the skin and is many times accompanied by fever, etc.); (e) faulty preparation by elimination of normal substances usually present, namely, vitamins and chemicals; (f) chemicals, such as arsenic, placed in food for criminal purposes or by accident. (*See also* ENTOMOLOGY, MEDICAL: Mechanical Carriers.)

Bacterial Contamination. One important type of food poisoning is due to the contamination of the

food with the paratyphoid-enteritidis group or other bacterial organisms, either through the agency of a human or animal carrier, particularly the rat, or from the meat of an animal suffering from a specific infection with these germs. Several instances have been brought to light of proprietors of food establishments and hospitals using the so-called rat viruses in attempting to destroy rats. These "viruses" usually contain bacteria proved to have caused outbreaks of food poisoning. Subsequent incubation of the contaminated food through improper and insufficient cooking, refrigeration or storage, allows the bacteria to secrete, in their growth, a poisonous product; or, perhaps, in the process of heating, certain products become soluble and evidently poisonous. The demonstration in the laboratory of a toxin or poison in the causative food is apparently associated with technical difficulties. Experimentally, however, there appears to be no doubt that heat-stable poisons can be produced by a group of bacteria usually classified as causative agents in food poisoning. Moreover, the white mouse is the most susceptible orally to certain bacterial poisons, and therefore, the logical laboratory animal for test purpose. The consumption of such food is followed within several hours by symptoms of nausea, abdominal pain, vomiting, prostration, diarrhea, and perhaps fever. Complete recovery within forty-eight hours is the rule.

Botulism. The other type of food poisoning is known as botulism. It is due to the contamination of the food with a specific bacterium known generally as the *Bacillus botulinus*. This germ is found in the soil practically throughout the world. It exists in nature in the form of a spore and as such is not poisonous. When so-called non-acid or slightly acid foods, such as many vegetables, like string beans and corn, fish or meat, are preserved by faulty and unsanitary methods, botulinus poisoning may occur. The symptoms usually appear within twenty-four to forty-eight hours after the consumption of the poisonous food. There may be marked muscular weakness, disturbances of vision, loss of ability to swallow and talk, constipation, rapid pulse and subnormal temperature, rarely any pain, and death from respiratory failure. This somewhat rare type of poisoning, so serious because of its high mortality, has apparently been eliminated from commercially canned foods. It is regrettable that home-canning methods antedate the present-day knowledge of botulism and that, with a few exceptions, no effort has been made to correct them. Only boiling for a sufficient length of time after removal from the glass jar or can before being served, or preservation in at least 10% brine solution, or processing in pressure cookers for sufficient time and temperature will make home-canned foods safe.

Diagnosis of Cases. In connection with investigations of food poisoning cases which have been made during the past few years, one important point is generally overlooked by attending physicians or health officers, and that is the necessity of confirming clinical findings by laboratory tests of samples of suspected

food and excreta of the persons made ill. Without such data the record of these outbreaks are of little value, either as indicating the real cause of the trouble, or suggesting how such outbreaks may be avoided in the future.

Many alleged outbreaks illustrate the fact that the term "ptomaine poison" has been loosely used in the past, and in investigating these cases not enough attention has been given to the exact type of the illness and its relation to the suspected food, both as to the manner in which the food itself was prepared and handled, and the time within which the illness developed. In most of the so-called "ptomaine poisoning" cases it is necessary to contend with the doctors' diagnoses. It is entirely too often that investigations are referred to and improperly made by the police and the coroner's office. The illness is frequently attributed to some suspected food, with no test of the food itself, and without acquiring a very accurate history of the patient's illness or trying to eliminate other factors which might have caused it.

Effects of Heat. The problem of food poisoning presents two paradoxes. In one type the bacteria are easily destroyed by heat, namely, the paratyphoid-enteritidis group, but the poison produced under certain circumstances is apparently resistant to heat. On the other hand, food poisoning by the botulinus group presents facts which definitely show that the poison produced in the growth of the bacterial spore is easily destroyed by heat while this organism as found in nature or in contaminated or poisonous food stuff is remarkably resistant to heat. J. C. G.

FOOD PRESERVATION. The preservation of food, though of ancient origin, is now one of the world's foremost industries. In 1930 in the United States alone, approximately 11,000,000,000 lbs. of fruits, vegetables, meats and other foods were canned in tin or glass hermetically sealed containers. The largest items are meats, milk, soup, tomatoes, corn and peas, various fruits and marine products. The annual consumption of canned foods in this country is about 75 lbs. per capita.

Preservation makes perishable foods available the year 'round. It allows tropical fruits to be used in temperate countries, stabilizes agriculture, promotes industry, makes for a more varied, adequate and palatable diet, and promotes efficiency of time in food purchase and preparation for the home maker. The following are various methods of preserving food: (1) Application of heat, which consists of sun drying, evaporation and dehydration, (2) Application of cold: freezing, cold storage, refrigeration, (3) Use of preservative substances: sugar-preserving, salting, pickling, preserving by vinegar, acids, spices, oils, carbon dioxide; legal chemicals but of doubtful effect upon health, represented by sulphur dioxide, benzoates, nitrites and alcohols, may also be used, (4) Fermentation: alcoholic, lactic and acetic, (5) Mechanical agents: filtration, vacuumization, use of inert gases, (6) Combinations of several of the above methods.

Usually the preservation of food involves several operations, for example, drying, vacuumization and canning. Dehydration is artificial removal of moisture by heat and controlled air blasts. Dried fruits, meats, spices, grains, fish, and occasionally vegetables are important examples of dried foods, though canning and the use of cold is gradually displacing them. Salt, sugar and vinegar are among the most widely used chemicals in food preservation. These substances inhibit spoilage when present in sufficient concentrations. Pickles, sauerkraut, Scotch-cured herring, ripe olives and corned meats are familiar examples of salted or pickled foods. Sugar is the principal preserving agent in jams, marmalades, preserves, candies and syrups. These products are often heat-treated in sealed containers as an additional safeguard.

The freezing of foods, especially fish, meats and fruits is a rapidly growing method of preserving these foods. Similarly, cold storage and refrigeration are important aids in retaining the fresh qualities of many raw foods such as fruits, vegetables, nuts, eggs, fish and meats. In both freezing and canning, many foods retain practically all of their original nutritive properties including the vitamins. Canned foods are subjected to temperatures sufficiently high to destroy effectively all pathogenic or spoilage-producing microorganisms, and are therefore entirely safe to consume in quantity. C. R. F.

FOOD RESEARCH, a form of research carried on by various agencies in the United States. Among them are the Federal DEPARTMENT OF AGRICULTURE, state bureaus of markets, agricultural colleges and experimental stations as well as the many research organizations of banks and business houses.

An institution devoted especially to scientific study of food was founded in Feb. 1921 under the name of the Food Research Institute. It was organized under the auspices of the Carnegie Corporation of New York working in connection with the trustees of Leland Stanford Junior University. During the World War the desirability of such an institution was forcibly impressed upon many when there was a need for scientific data on the production, distribution and consumption of food. Important research had been done in the field, but there was no coordinated agency for a scientific study of food on a national or international scale. Herbert Hoover, who had been National Food Administrator during the World War, is credited with having suggested the establishment of the Food Research Institute, and its location at Stanford was due in part to the fact that the university has a large collection of important material on food problems and other aspects of the World War. An appropriation of funds to carry on the work was made by the Carnegie Corporation. The Institute has been headed by three directors and organized as a department of Stanford University wherein research work is carried on and from which students are graduated with degrees. The aim of the Institute is to cooperate with other food research agencies. It does not contemplate extensive experi-

mental work on its own account, although it maintains laboratories and facilities for its graduate students. M. J. Q.

FOODSTUFFS, or "articles of food," may be considered from three points of view, viz. their origin, their economics, and their significance in nutrition. From plants may be taken directly (1) the seeds which furnish breadstuffs and other grain products, (2) the fruits and (3) various other edible parts of plants, called collectively vegetables. Or use may be made of animals to convert the plant products into meat, milk or eggs. Or by manufacturing processes certain sugars and fats may be separated from the plant or animal tissues which contained them, and marketed in their isolated forms.

Breadstuffs and other grain products are still the staff of life for the majority of mankind. On almost any arable land in almost any climate, some form of grain crop can be grown, and usually at a labor cost relatively less than for most other foods. Once matured the grains can easily be kept so as to be a staple article of food throughout the year. For a combination of such reasons the breadstuffs and other grain products—RICE, OATMEAL, and the corresponding products of BARLEY and MAIZE being the analogues of bread in the regions which do not grow WHEAT and RYE—are in most countries and at most times of the year the most economical foods "so far as they go." One cannot live on them alone: they lack some of the needed vitamins (*see* VITAMINS IN Food) and are too poor in some of the mineral elements; but they are economical sources of calories and protein, and, in general, the more economically people must live the more largely they subsist upon bread or other grain products. Thus this type of food furnishes, of the total calories consumed by the people, about one-third in America, probably about one-half in Western Europe, probably two-thirds to three-fourths in Russia and the Orient. (*See also* FLOUR; WHOLE WHEAT FOODS.)

Hence failure of grain crops means famine. But to be obliged to live solely upon the foodstuffs which the grain products furnish, quickly becomes a severe hardship and sooner or later leads to Scurvy or some other nutritional deficiency disease.

Fruit is prized both for its flavor and for its refreshing and wholesome qualities as food which were always instinctively realized and have now been scientifically explained. But the popularity of fruit and its perishable nature combine to make it relatively costly at most times and places. On this account the teaching of food values in the past has tended to regard fruit as a luxury. Now, with the understanding of its value in supplying the essential mineral elements and vitamins (and also in helping to maintain a good condition of intestinal hygiene), fruit is looked upon with favor as a good investment; but some of the vegetables yield much the same virtues as the fruits and at less cost, because the eating of them is not so great a pleasure and therefore they are not so eagerly sought.

Vegetables differ widely in many of their characteristics; but vegetables like fruits (and there is no sharp distinction between them) are in general of high significance as sources of the mineral elements and vitamins which the breadstuffs and other CEREALS do not satisfactorily supply, and so the present-day development of fruit and vegetable marketing facilities and market news services are of real value to consumers and producers alike.

As many plant tissues are too harsh or too bulky for the human palate and digestive tract, such plant tissues are utilized not directly as food but indirectly through the animals which transform them into meat, milk or eggs. But no animal organism can "work for nothing" (any more than any machine can yield us perpetual motion) and so when plant products which could be used directly for human food are fed in part to animals instead, the animal products must needs be more expensive, relatively to food value furnished, than the plant products fed to produce them, except in so far as they supplement the food supply in some essential way.

Meats are most popular and occupy the largest place in the food budget (*see* FOOD); but they are expensive sources even of protein and fat, and in general they are deficient in about the same mineral elements and vitamins as are the breadstuffs.

Milk is produced at less cost of food nutrients than is meat, and is correspondingly a more economical food; and what is even more important, MILK is much the most effective of all foods in supplementing the breadstuffs and other grain products and ensuring the all-round nutritional excellence of the diet. Milk is the one article of diet whose sole function in nature is to serve as food, and the one food for which there is no fully satisfactory substitute. As knowledge of food values increases, milk takes an increasingly prominent place among foods.

Both in economy of production and in nutritive value, eggs occupy (*see* EGGS AS FOOD), in general, a position intermediate between meat (*see* MEAT AS FOOD) and milk (*see* MILK AS FOOD) but in the average food budget they occupy a much smaller place than either meat or milk.

Fats are a concentrated form of food-fuel and have special significance both in conferring the flavors and textures often desired in cookery and in making food feel more satisfying because it "stays by" in the stomach. BUTTER is also very important for its vitamin value. Sugar and other sweets are quick forms of food-fuel. *See also* IRRADIATED FOODS; FOOD SUPPLY OF THE WORLD; FOOD PRESERVATION; FOOD RESEARCH; DIET AND DIETETICS.

H. C. S.

FOOD SUPPLY OF THE WORLD. The most important elements are the cereals (*see* CEREALS AS FOODS), for they occupy at least two-thirds of the total cultivated area of the world, if we exclude buckwheat, grain sorghums, millets, fruits, beans, peas, and some minor crops. WHEAT represents three-tenths of the area under cereals and about one-fifth of the cultivated area. The production of the differ-

ent cereals, however, is not proportional to the crop area they occupy because the yields are very different. RICE is the highest yielder, CORN a close second, and wheat one of the poorest yielders of all cereals. Nevertheless, because of the large acreage, if we exclude China for lack of data, the wheat crop is the largest, with corn next, and rice third. With China included, the order might prove to be rice, wheat, corn.

Wheat must be regarded as the premier cereal, not merely because of the vast acreage it occupies and the diverse regions and climates in which it grows, but also because of its commercial importance. The volume of international trade in wheat is between two and three times as large as the volume of trade in corn, which ranks second in regard to volume. Some 20% of the production of wheat in the world, excluding China, moves in international trade. In no other cereal does the trade amount to as much as 10% of the production. The trade in RYE and OATS is a notably small fraction of the out-turn of those crops. In general, the cereals are consumed in by far the larger part in the countries where they are produced. This situation prevails even more strikingly with regard to POTATOES. Hardly more than one per cent of the production passes into international trade. In sharp contrast is the situation with such crops as SUGAR, COTTON, and COFFEE. Nearly 52% of the raw sugar produced in 1926-29 passed into international trade, nearly 63% of the lint cotton, nearly 79% of the coffee. All these ratios might be altered, if account could be taken of China.

The only non-cereal crop that competes in volume of production with wheat or rice is the potato. Though the acreage is small, the yield per acre is many times that of any cereal. Nevertheless, the food values represented by the potato crop are small as compared with cereals, since cereals contain but 10 to 15% of moisture, whereas potatoes contain 75 to 80%. The relatively insignificant role of the potato in furnishing calories (*see* CALORIES IN FOOD) is evident from the composition of the American dietary: Animal products furnish about 40% of the total calories; cereals, about 34+%; tubers, roots and stalks, 17%; oilseeds, 5%; fruits and vegetables, 3%; and LEGUMES, 1%. With 'tubers, roots and stalks,' are included potatoes, sugar, cassava, sago, and tapioca, sugar alone furnishing something over 13 of the 17%. In some countries of northern Europe, the potato, as well as wheat and rye, plays a much more important role than in America. While wheat alone furnishes only about 26% of the calories in the American diet, in pre-war Russia, for example, the cereals furnished about 75% of the total calories, and in Japan, the cereals, preponderatingly rice, furnish about 87%. All over the world, there is a trend towards increase in sugar consumption and in many countries there is a growing use of fruits and vegetables, due to better understanding of their value in the diet and to improvement in transportation, refrigeration and other methods of preservation. There is also in occidental countries increasing consump-

tion of vegetable oils, derived from oilseeds, relative to animal fats. Oilseeds include coconut, peanut, walnut, almond, pecan, cottonseed, olive, sunflower seed, palm and palm kernel, sesame seed, rapeseed, flaxseed, and soy bean (strictly speaking a legume) oils.

While wheat and rice are principally primary foodstuffs, i.e., consumed directly by man, a very large part of the other cereal crops is not so consumed, but fed to domesticated animals to produce animal foodstuffs as meat, lard, eggs, poultry, milk, etc. These latter foods, not being direct products of the soil, may be termed secondary foodstuffs. Primary foodstuffs are the direct product of the growth of green plants and can be consumed by man directly. Secondary foods are produced by feeding to animals the direct product of the soil which may be edible for man, like corn, or inedible, like hay. If the feeding stuff is not suitable for human food, or if it is produced upon land not capable of primary food production, such as range land, or if it is a by-product of primary food production, for example straw, the resulting secondary food is a clear gain for the total food supply. If, on the contrary, the secondary food is produced by feeding materials fit for human consumption, for example wheat, or materials which, while in themselves not fit for human food, have been grown upon land that might have produced primary foodstuffs, for example ALFALFA, the meat animal competes with man for the product of the soil. Animal foodstuffs thus produced can add to the total supply only if the meat, milk, and eggs obtained are the equivalent of the feed consumed. As a matter of fact, the efficiency of such conversion of primary into secondary foodstuffs is low. For a hog in terms of calories, it ranges somewhere between 25 and 40%. Dairying is the most efficient process of producing secondary foods; poultry and steer-beef production, the least efficient. The energy of the feed which is not recovered is dissipated, and goes to maintain the animal and permit it to live and perform its vital processes.

It is evident, then, that any discussion of the world's food supply and the potentialities of food production must define the nature of the diet. A people living principally upon secondary foodstuffs, i.e., animal foods, must require a vastly greater area of agricultural land to supply its needs than a people living on primary ones, that is to say on a wholly vegetable diet. Upon it probably no nation could remain vigorous. It might, however, exist upon a diet consisting of bread grains, oilseeds, fruits and green vegetables, such animal foodstuffs as MILK, the meat of calves and of cows which are no longer efficient milk producers, and the eggs and meat of self-supporting, foraging hens, the products of the sea and inland waters, the mutton which is a by-product of wool growing, and the meat of animals like cattle and goats produced upon ranges and other rough land. There is nothing on record to indicate that such a diet is not entirely wholesome. If the world were

put to it, it might adopt such a diet, and could then support a vastly greater number of people than upon a diet containing a large proportion of secondary foodstuffs.

Peoples like the Chinese and the Japanese, because of poverty, actually exist on a largely vegetable diet, with a very small proportion of secondary foodstuffs. From conditions found in these countries, and formerly in Europe, it has been argued that a world shortage of food is impending, and that with increasing population the per capita production of food must diminish since the area of land available on earth is circumscribed and there are limits to the possible increase in production per unit of land area. The history of the last hundred years has demonstrated that it is idle to make prophecies of this sort. That the world's population will increase indefinitely is merely an assumption. There are abundant indications, at least for the white races, that with rising standards of living, the rate of population (see POPULATION) increase falls off. There is at present no reason to doubt that as the standard of living of other races increases, their rate of population increase will also diminish. Furthermore, while it is true that the LAW OF DIMINISHING RETURNS applies to agriculture under a given state of development of the art, it does not follow that with the progress of science and invention the productivity of land must remain what it is today. Moreover, agriculture is spreading into new regions constantly and there are few sections of the earth for which it is safe to say that agriculture will never be possible. In short, there are so many unforeseeable elements in the situation that to prophesy a shortage of the world's food supply within any reasonable period of time is as yet an idle speculation. C. L. A.

FOOLS, FEAST OF, a medieval popular festival in the Christmas season, especially Dec. 28 (HOLY INNOCENTS), and Jan. 1 and 6. It was doubtless a survival of the Roman *Saturnalia*, at which the masters waited upon their servants and the world was "turned upside down." There were special ceremonial books or rituals for these feasts, some of which are still extant. After 633, popes, bishops and councils forbade them, but they nevertheless persisted for a long time and the theological faculty of Paris went so far as to defend them. It prohibited them, however, in 1544, and such as remained received their death blow by an act of parliament in Dijon, 1562.

FOOL'S PARSLEY (*Æthusa Cynapium*), a parsley-like weed, called also fool's cicely, with poisonous foliage emitting a nauseous odor. The plant is widespread throughout Europe and Russian Asia, with the exception of the extreme north, and is somewhat naturalized in waste places in eastern North America. It is a smooth annual herb with branching stems 1 to 2½ ft. high bearing much dissected, somewhat shining leaves and small white flowers in long-stalked compound clusters (umbels).

FOOT, the terminal portion of the lower extremity. Man and the higher apes are among the few mam-

mals who walk on the whole lower surface of the foot. In some mammals only the toes and ball of the foot or the toes alone touch the ground (cat, dog), in others only the tips of two toes touch the ground (artiodactyls: hogs, cattle, deer), while in the horses only a single toe-nail is in contact with the ground (perissodactyls).

The bones of the foot are considered in the article SKELETON, the arteries are discussed in ARTERIAL SYSTEM, the nerves in NERVOUS SYSTEM, and the muscles in MUSCULAR SYSTEM.

FOOT-AND-MOUTH DISEASE, a virulent contagious disease affecting all domestic animals, particularly cattle. It can be transmitted to man. The disease begins suddenly and spreads very rapidly. The first symptom is usually fever, followed by the appearance of vesicles in the mouth and nostrils, and where the skin is thin, as on the udder, between the claws of the feet and on the heels and plastron. The blisters gradually enlarge and run together forming a highly painful raw patch. In cows, the milk flow lessens and a pregnant animal often aborts. Lameness is common and the feet often become so affected that it is necessary to kill the animal.

The disease is spread by contact with any of the secretions or excretions and can be produced by injecting fluid from the vesicles. It is not usually fatal except with young animals. Epidemics, however, have been widespread and have caused great loss.

Treatment consists of applying antiseptic solutions or powders to the wounds and giving a laxative diet. Affected animals should be isolated and their quarters thoroughly sterilized. As with so many contagious animal diseases, prevention is the best cure.

FOOTBALL, as an organized game, first appears in history among the Spartans, by whom it was played as early as 500 B.C., under the name of ἀρπαστόν (harpaston). The Romans adopted this game, slightly Latinizing its name into harpastum. It is believed that it was the Roman legions who carried the game from Greece to Rome and later into Britain, for football was distinctively a military pastime in Rome in the same manner in which polo flourishes among soldiers to-day.

Julius Pollux, an Egyptian sophist of the 2nd century who taught at Rome under Commodus, left among his writings a brief description of this game. "The players divide themselves into two bands. The ball is thrown upon the line in the middle. At the two ends of the field, behind the line where the players are stationed, are two other lines beyond which these two bands endeavor to carry the ball, a feat that cannot be accomplished without pushing one another backward and forward." This description presents, notwithstanding its brevity, a football field marked upon the ground with center line and goal lines and naturally with side lines, with the familiar personal collisions of the players, and with a score achieved by forcing the ball across an adversary's goal line.

Sir Geoffrey Chaucer writing almost 600 years ago, alludes to football in his *Knight's Tale*:

"Ther stomblen stedes strong and down goeth all.

He rolleth under foote as doth a ball."

William Fitzstephen, an earlier writer, in his *History of London*, written in 1175, pleasantly pictures a game of his time:

"After dinner all the youth of the city go into the fields and address themselves to the famous game of football. The scholars of each particular school have their football and the particular trades have theirs. The elders of the city, the fathers of the parties, and the rich and wealthy of the city come to the fields on horseback in order to watch the exercises of youth."

Thus, this genial old chronicler presents to us the basic features of a football game in his day and also in our own.

It is not difficult to find the historic thread of football running through the literature and the laws of England from the days of Chaucer down to the present time. It is found in the laws because the popularity of football continually detracted from the practice of archery, the mainstay of a warring nation. Thus Edward II issued a proclamation against the sport, Apr. 13, 1314, as follows:

"Forasmuch as there is a great noise in the city, caused by hustling over large footballs, from which many evils arise, we command and forbidde on behalf of the king under pain of imprisonment such game to be played in the future."

The game evidently challenged suppression, for 35 years later Edward III renewed the prohibition of his predecessor by issuing an edict, still extant in the Close Rolls, 12 Edward III, which prohibited "Manualem, pedinam, baculoream, et ad cambucam." Devotees of modern sports afield will recognize beneath these names in law-Latin, their beloved handball, football, hockey and golf.

But the sport continued to flourish, defying other kings and queens, publicists and moralists. Robert Burton in his *Anatomic of Melancholie* supported the game. Philip Stubbs, another author of an *Anatomic*, opposed it. "For as concerning football," he writes, "I protest that it may rather be called a friendlie kinde of a fyghte than a play or pastime." Thus it will be seen that modern opposition to football has its roots abundantly but vainly in the course of ancient English history.

National Game in England. From other literature of the past six centuries we learn that football as an organized game existed generally throughout England, as a national institution. At times town challenged town and parish challenged parish. The goal usually was a municipal building in each town or the church in each parish. There might have been miles of country between the two goals, as there frequently were; but everybody was eligible to participate in the game. Thus the battle raged for hours or an entire day over the countryside, until one side or the other had kicked the ball into the other's town or parish or, if more particular, against their opponents' townhall or church. In all of these games the ball invariably was kicked and never carried. It is from these old

days that collegiate football of America and its English predecessor, Rugby, derive the oval shape of the ball and its familiar name of "pig skin." An inflated pig's bladder was used for the ball, and since then footballs have always been made of grain leather.

The honor of converting these crude sports of England into ingeniously organized games belongs to the great secondary schools of England, to Eton, Rugby, Harrow, Westminster and others. Each of these schools developed a game peculiar to itself many years in advance of the entrance of the sport into the English universities. In fact intercollegiate football in America is an older institution than its English university counterpart. At no time, however, prior to 1850 did the idea of an interscholastic game arise, each school finding sufficient entertainment in its own intramural teams. In all of these school types of football games carrying the ball was prohibited.

It was in 1823 that by chance the principle of carrying the ball originated. A hundred boys, evenly divided, were playing their kicking game on Old Bigside at Rugby. Neither team had scored, and the school bell was about to peal forth the hour of five which would terminate the game. Down the field came a long sailing punt. It was caught by a player by the name of William Webb Ellis. Under the rules he should have kicked it back, or heeled his catch for a free kick at goal. Instead, in violation of the rules, he tucked the ball under his arm and carried the ball up the field, clearing all opponents and crossing the line just as the hour of five rang out across the field.

This sensational performance at first was censured; but in a few days the school boy leaders perceived in the feat an idea for a new type of game. They soon after revised their rules, making the carrying of the ball the distinctive feature of the Rugby game.

ASSOCIATION FOOTBALL

During the ensuing 40 years many football teams were organized throughout England, some based upon the kicking principle and others using the Rugby code. The prevalence of many sets of rules prompted the football teams of London which believed in the kicking game to hold a convention. Thus a conference of all of the kicking teams of the city was held at the Freemason's Tavern in Great Queen St., Dec. 1, 1863, at which a uniform code of rules was drafted and where the teams present formed themselves into the London Football Association. Hence the style of game provided by the rules adopted on that day, which prohibited carrying the ball, has always been known as "Association." The term soccer is merely a humorous derivative from the word Association.

Although Association football has been periodically subjected to changes in the seven decades that have come and gone since that historic convention of 1863, the total sum of these changes is slight. To-day this type of game is the most popular of all games in England, annually drawing crowds of one hundred thousand and upwards to the final encounters. In

the United States, also, within the past 30 years it has obtained a firm foothold and is played far and wide. It is more popular outside of college circles, although all of the major universities have their soccer teams.

Rules of Game. The Association game is played to-day by 11 men upon a side. These consist of four forwards who deploy along the center line. They are designated respectively as outside left, inside left, inside right, and outside right. Slightly behind the center of the middle line stands a fifth player known as the center forward. Behind him, left and right, are two more players known as the left half and the right half. Midway between these two latter players but in their rear stands the eighth player of the team, designated as center half. Behind him, left and right, are another pair of backs also designated as left half and right half, with the 11th player called the goal keeper standing in the goal. The latter consists of two posts set on the goal line at center, with a cross-bar reaching from post to post. A goal in this type of game is scored by kicking the ball between the posts and underneath the bar across the goal line. The dimensions of the field may vary but must be of a minimum length of 100 yards and must not exceed a maximum length of 130 yards. The width may be 50 yards and must not exceed 100 yards.

Methods of play in soccer are very simple compared with English and American Rugby. The ball is kicked off from center by the center forward of the side winning the toss and choosing the ball. This kick is usually a dribble, an adroit kick which kicks the ball without losing control of it so that the center forward may continue kicking it forward by short kicks. As in this game the players maintain their relative positions, each covering his own zone, the art is to pass the ball from player to player until at last it is kicked at the goal. The methods of the defense are for the backs to take the ball away from the offense, thus in turn becoming the offense and to dribble the ball back up the field towards their opponent's goal. No player may seize the ball except the goal keeper who must instantly kick it. The ball also may be propelled by being bunted with the head of a player.

RUGBY FOOTBALL

The advancement of the sport in England in 1863, by the formation of the London Football Association by the teams playing the kicking type of game, prompted the Rugby teams also to form a sovereign organization. Accordingly, Jan. 26, 1871, 36 Rugby teams met in the Pall Mall Restaurant in Regent St., organized the Rugby Football Union and adopted a uniform set of rules, the predominant characteristic of which was the carrying of the ball.

The Rugby type of game, like its Association comrade, has run into several storms since 1871, but it is substantially to-day the same old game. Its chief changes have been in playing methods. In popularity it is second in England to soccer. About 1925 it began to secure a foothold in the older and major football

colleges of the North Atlantic seaboard and to-day is regularly played by Harvard, Pennsylvania, Princeton, Yale and others.

Game in England. Modern Rugby football, of the English type, is played upon a field 110 yards long and not exceeding 75 yards in width. The field is marked by side lines and goal lines, with a parallel line along the side lines and five yards distant therefrom, known as the broken line. The field is divided by a half-way line and subdivided by 25-yard lines. A short line 10 yards behind each half-way line and called the 10-yard line also is marked upon the turf. The game is played by 15 players upon a side. These are divided into eight forwards, two half backs, four three-quarter backs and one full back. The ball is put in play by a device known as a scrum. The eight forwards on each side divide into three ranks, with three men in the front row, two in the middle row and three men in the back row. These three ranks mass one behind another, the two masses of players facing each other at midfield. Between them a player, known as the scrum half, inserts the ball, whereupon the middle man in each front rank endeavors to obtain possession of the ball by hocking it backward with his foot to the middle man in the rank behind him, until it thus comes out of scrum, when it is picked up and carried forward.

Opponents endeavor to tackle the carrier by seizing him around the waist or to hold him by seizing him so that he cannot pass the ball. A player when about to be tackled or held passes the ball if possible to a player behind him, who thereupon endeavors to carry it further forward. Scoring may be accomplished in five ways. If the ball is carried across an adversary's goal line it is a try and counts three points, besides entitling the scoring side to try for a goal by a free kick from the field. If the latter is successful two points additional are added to the three already obtained. If a goal from the field is kicked by a drop-kick four points are awarded the kicking side. If a goal is scored by a penalty kick three points are awarded, and if the goal be scored from a mark by a free kick, three points are counted thereby.

Intercollegiate Games in America. In America throughout the 19th century football was played at the older colleges of the East in a haphazard way, without rules and without order. After the close of the Civil War a game developed at Princeton patterned after the Association type. A similar game in these same days also evolved at Rutgers College, 25 miles distant from Princeton. These happy circumstances prompted the senior football leader at Princeton, William S. Gummere, who in 1901 became Chief Justice of the Supreme Court of New Jersey, to conceive the idea of an intercollegiate game. Accordingly he challenged Rutgers, and the latter through its senior leader, William S. Legget, accepted. This game, the first intercollegiate game of football in the world, was played at New Brunswick, Nov. 6, 1869, Rutgers winning six goals to four.

In 1870 Columbia University joined Princeton and

Rutgers in a mutual schedule of games. In 1871 no games were played, but in 1872 the sport was revived and augmented by the appearance of Yale which defeated Columbia. In this same year, on Feb. 10, Oxford and Cambridge engaged in their first game, Oxford winning by a goal from a try. In the following year, 1873, Princeton, Rutgers and Yale held a convention in New York and drafted a set of rules, still following the Association code. Under these rules, Nov. 15, 1873, Princeton and Yale met in their first football encounter, at New Haven, Princeton winning three goals to Yale's none.

Collegiate Rugby. And now we come to the capital circumstance which promoted the establishment of the Rugby type of football in intercollegiate America. In the spring of 1874 David Roger, captain of the Rugby Fifteen at McGill University in Montreal conceived the idea of playing Harvard. Accordingly he challenged, and Captain Henry R. Grant of Harvard accepted, but specified that two games should be played, the first May 14 under Harvard's rules and the second May 15 under Rugby rules. The first game, Harvard's initial bow as an intercollegiate contender, resulted in a victory for Harvard, three goals to none. The following day the second game was played under Rugby rules, the contest terminating in a draw. The Rugby style of game instantly captured the admiration of the football leaders of Harvard. In the fall of 1875, they abandoned their style of play, a combination of Association and Rugby, adopted the Rugby code and challenged Yale. Nathaniel Curtis was now captain of Harvard and William A. Arnold was leader of Yale. The challenge was accepted. The game was played at New Haven, Nov. 13, 1875, Harvard winning by four goals to Yale's none.

Two of Princeton's football leaders, W. Earle Dodge and Jotham Potter attended this game. They instantly recognized the merits of the Rugby code. In the following autumn they invited Columbia, Harvard and Yale to meet Princeton in a convention at the old Massasoit House in Springfield, Mass., for the purpose of forming a football association, adopting the Rugby Union Code and scheduling a mutual set of games. This convention met Nov. 23, 1876, and carried out all three objects. The great institution of collegiate Rugby football of to-day is the direct descendant of the game adopted that day, evolved into a distinctive American game by many changes but nevertheless still preserving sufficient of its Rugby fundamentals to be instantly recognizable as a derivative from English Rugby.

Collegiate Rugby has functioned in America for 56 years. Its popularity has given it an influence far beyond that of a mere game, and has caused it to be so effective in so many ways outside of sport that it may justly be termed an American institution.

Important Change in Rules. At the time Columbia, Harvard, Princeton and Yale adopted the Rugby Union Code they made one change, but that change was of great importance as years came and

went. Rule 7 of the Rugby Code provided for the computation of the score by goals alone. The young collegians of 1876 made the touchdown the basis of scoring but made a goal equal to four touchdowns. The genius of young America for invention and improvement, however, instantly attacked the Rugby rules. Yale under the leadership of that mighty master of the sport, Walter Camp, in 1878 demanded that the Rugby principle of 15 players upon a side should be abolished and that the Eton number of 11 should be substituted. This suggestion at the time was rejected. Camp renewed his demand in 1879 and coupled with it a second demand that the size of the English field should be reduced. Again he met defeat. In 1880 he again appeared in the Intercollegiate Convention of that year and renewed his two demands, and now added a third radical proposition that the scrum, the English method of putting the ball in play, should be abolished and in its place should be substituted a distinctively American system which would give to one side orderly possession of the ball with the right to put it in play and to execute the ensuing attack, this system to be called a scrimmage, thereby permitting the introduction into the game of prearranged formations, plays, tactics and strategy. Robert Bacon, later to become a famous statesman, was captain of Harvard in that year and had as a counselor Robert Winsor, another player destined to become a great leader of finance and industry. In Princeton's football councils in that year was a player by the name of James S. Harlan, also to become a far visioned statesman. These men championed the plans of Walter Camp, and so in the ensuing convention all of his proposals were adopted thereby making out of English Rugby a distinctive American game.

And now came and went a decade of fascinating football. Tacticians studiously assigned the 11 players upon a side into seven forwards, a quarter back, two half backs and a full back. Ingenious maneuvers were devised and signals introduced. At Princeton, an extraordinary tactician by the name of Richard Hodge, invented guarding, or the use of a player on each side of the carrier to prevent tackling from the side, the forerunner of interference. Later he introduced the maneuver, now known as boxing the tackle, and finally Princeton's famous V Trick, the original wedge and forerunner of momentum mass play. Yale with equal ingenuity utilized its celebrated guard, Walter Hieffelfinger, by employing him in the interference, thereby originating that principle of modern tactics. Harvard produced the original unbalanced or off center tandem backfield formation. In these same years the intercollegiate convention extended the Rugby rule limiting tackling above the waist to the knees as the restraining line. As a background to these activities great games were waged; small throngs of collegians as spectators began to grow into a public patronage of thousands. Huge wooden stands began to arise, and the game invaded the colleges of the Middle West and the South.

With the arrival of the '90s the game crossed the

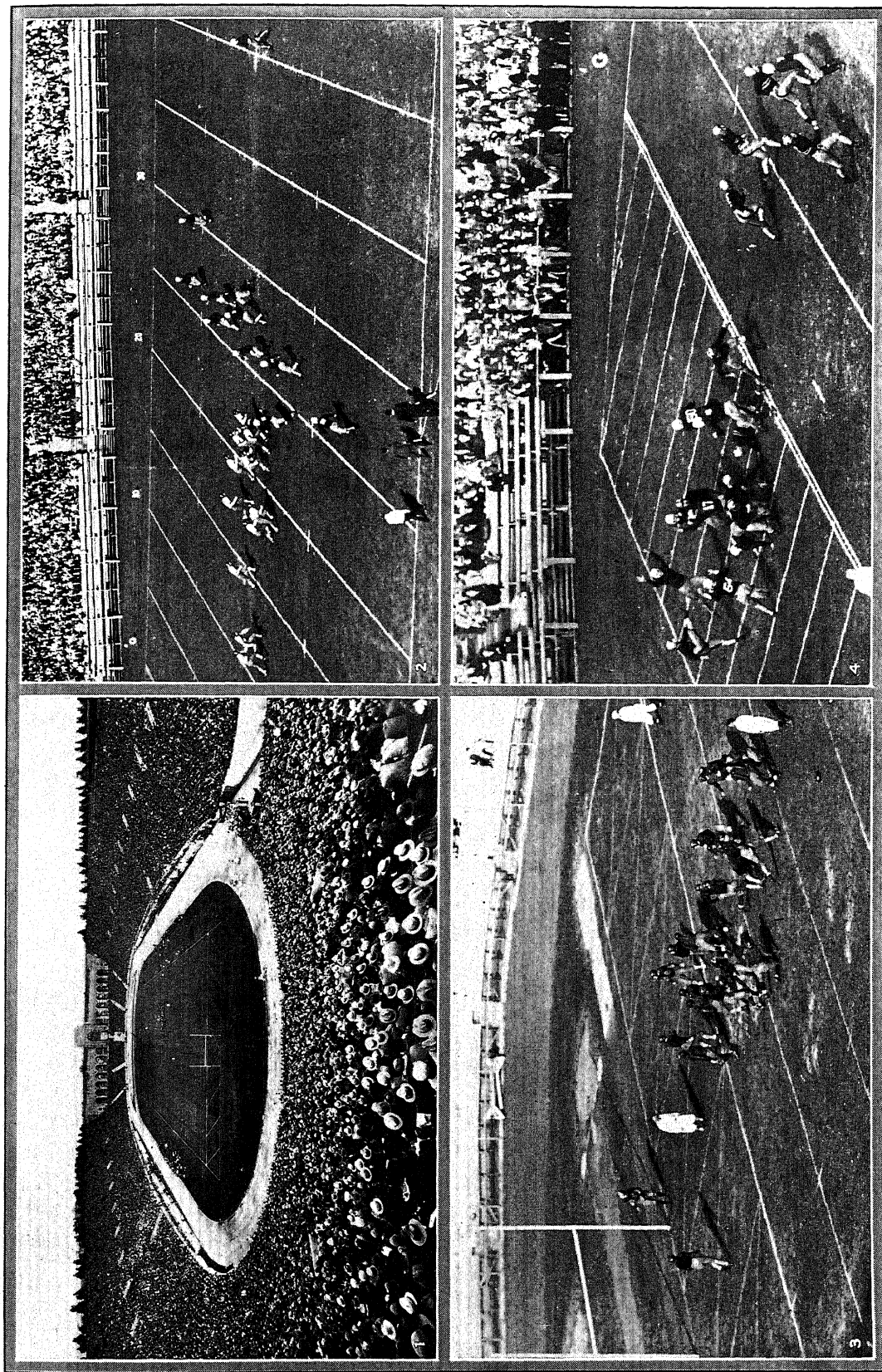
Mississippi and quickly made its way to the Pacific Coast. By the middle of this decade it had become the monarch of collegiate games. Early in this decade Harvard sprung against Yale the most sensational and spectacular maneuver in the annals of the sport, the famous flying wedge, incidentally introducing into the technique of the sport the principle of flying interference, that is interference which started in motion before the ball was put in play.

Undergraduate Rule. In this period Woodrow Wilson, then Faculty Chairman on sports at Princeton was publicly advocating the limitation of players upon college teams to undergraduates, a principle known at the time as the undergraduate rule. Adherents of this principle joined with the opponents of momentum mass plays and in 1893 wrought a revolution. Both graduate players and momentum mass plays disappeared from the collegiate sport. The gridiron in this decade was the training ground for many future famous Americans. In the position of guard at Amherst was Harlan P. Stone, appointed in 1925 as Associate Justice of the United States Supreme Court, and in the center of the line at Tufts was John Sargent, later a Federal Attorney General. Future United States senators, congressmen, governors, ambassadors, lesser officials and captains of industry were running ends, bucking the line, tackling and going down the field under punts. An impressive example of the indirect force of the popularity of the sport is found in a great institution which changed its name. Until 1896 the official name of Princeton had been the College of New Jersey. Its athletic teams, however, since 1870, had worn upon their shirts the name of the town, Princeton, thus popularizing the latter name to such proportions that eventually the College of New Jersey formally became Princeton University.

Open Play Increases Popularity. From the adoption of the low, or knee tackle, in 1888, the tendency of tactics had been towards close formations, the heavy mass formations in which the public seldom saw the carrier or the ball. Opposition to this type of tactics culminated in 1906 in another revolution. The college authorities and the public demanded a reformation of its tactics or an abolition of the game. The Rules Committee which in the revolution of 1893 had supplanted the old Intercollegiate Convention as football's legislature, forced the return of open play by inventing and introducing the forward pass and by requiring a team on offense to advance the ball 10 instead of five yards to achieve a first down.

This spectacular maneuver, the forward pass, not only brought an open play but added enormously to the interest of the public in the sport. The towering wooden stands no longer could accommodate the thousands and thousands who clamored for admission. Instantly into being, one after another, came the gigantic structures of concrete and steel which have taken the old Grecian name of stadium. Treasuries of the major football institutions whose budgets in the '90s were deemed dangerous when near \$50,000 now showed gross incomes of hundreds of thousands and

FOOTBALL



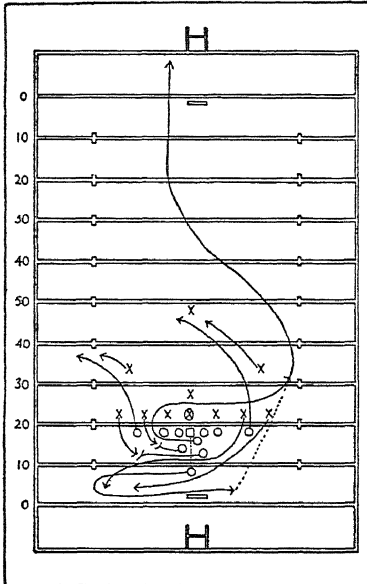
1, COURTESY LOS ANGELES CHAMBER OF COMMERCE; 2, 3, 4, KEYSTONE VIEW CO. PHOTOS

FAMOUS FOOTBALL GAMES AND PLAYING FIELDS

1. Coliseum at Los Angeles, California, scene of the 1932 Olympic Games.
2. Kickoff in the Yale Bowl, New Haven, Connecticut. Georgia v. Yale, Oct. 10, 1931.
3. Kicking the extra point after a touchdown. Michigan v. Princeton, at Princeton, New Jersey, Oct. 31, 1931.
4. Army man punting out of danger from behind his own goal line. Yale v. Army, at New Haven, Oct. 24, 1931.

eventually a million dollars. The little group of 50 spectators which attended the Princeton-Rutgers game in 1869 at the Army-Notre Dame game in 1929, 60 years later, had been replaced by a throng of 110,000 persons.

The new decade, 1930, however, brought a new feature into Collegiate Rugby football which must change



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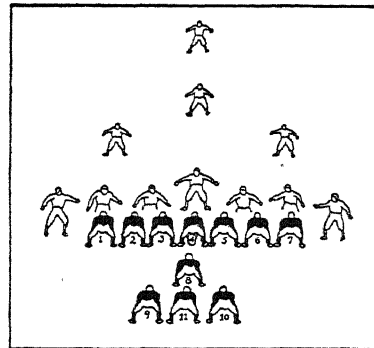
DIAGRAM ILLUSTRATING EXECUTION OF
A FORWARD PASS

its name to American Rugby, for Scholastic Football in the United States was found to have surpassed many times its college counterpart. In 1930, 550 college teams played football. Ten thousand school teams also waged the game. In 1930 14,000 college players played football; in the same year 300,000 school boys romped the gridirons. Sixteen million people saw the college games, and 24,000,000 spectators attended the scholastic contests.

General Rules and Methods. Collegiate Rugby Football in the United States has been subject to a change in the rules in every year since 1876, excepting 1877 and two years of the World War. In fact, changes in the rules have become an annual feature in the sport, precisely as the change in fashions in hats and clothes. Out of the total sum of all these changes scattered along the pathway of 56 years, the game stands forth to-day as played upon a field 120 yards long by $53\frac{1}{2}$ yards wide. This field is divided into three sections. There is at each end of the field a zone 10 yards wide known as the forward pass zone. Between these two zones is a playing field 100 yards in length divided by white lines into 20 sections, each five yards in width, thus giving to the field the appearance of a gridiron, whence it derived that familiar name. The goal posts, $18\frac{1}{2}$ feet in width, connected by a crossbar 10 feet above the ground, are set in the center of the end lines. The game is played by 11 players divided into seven forwards and four backs.

The forwards are designated as left end, left tackle, left guard, center, right guard, right tackle and right end. The backs are known as the quarter back, left half back, right half back and full back, although many modern back field formations have erased the distinction of left and right and caused the backs to be numbered one, two, three and four.

The ball is put in play from the center of the field by the side winning the right through the toss of a coin. This play is a kick-off by which maneuver the ball is kicked far down the field where it is caught by an opponent and run back until the opponent is caught and thrown by an adversary, the latter process being known as a tackle. The team in possession of the ball is now given four chances, called downs, to advance the ball 10 yards, failing in which it must surrender the ball to the opponent at the spot of the last down. The offensive team may carry the ball forward or may throw it forward to be caught by one of their own side. It is customary for the offensive team on the next to the last down in its attempts to advance the ball, perceiving that it cannot make the required 10 yards, to kick the ball far down the field, thus delivering it to their opponents at a point near the latter's goal. To achieve the advances of the ball, the offensive team executes various highly ingenious, strategic



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BALANCED OR SYMMETRICAL FORMATION

and tactical formations and maneuvers which are prepared and practiced long in advance of the game and are brought into action by the use of signals, thus making the game a veritable chess game with living men. This pre-arranged strategy is a distinctive feature of Collegiate Rugby over other football games. Scoring is accomplished by carrying the ball across the adversary's goal line, a feat known as a touchdown and counts six points. A touchdown entitles the scoring side to put the ball in play on their opponent's one yard line, and if they can score again by carrying the ball across the line or by executing a successful forward pass across the line or by kicking the goal, they are permitted to add one point to their score. Scoring also may be achieved by throwing the ball forward and across the goal line to be caught by a player of the throwing side within the forward pass zone. Such a play also is a touchdown and subject to the same privilege as a touchdown obtained by carry-

ing the ball across the line. A third method of scoring is to kick a goal from the field. Such a kick may be a drop kick or a place kick and must pass above the bar and between the posts or the posts projected. A field goal counts three points. If the offensive eleven sends the ball behind their own goal line and it is there touched down or forced down, it is called a safety and counts two points for the opponents. The game is 60 minutes in length, divided into four quarters of 15 minutes each, with an intermission of one minute between the first and second quarters and between the third and fourth quarters, but with 20 minutes between the second and third quarters. The game is awarded at the expiration of the playing time to the side which has amassed the greatest number of points.

In Feb. 1932 the National Football Rules Committee announced the following modifications of the playing code, made to check the "tendency toward increasing injuries": Five players of the team receiving the kick-off must remain on their 45-yard line until the ball is kicked, the kick-off being made either by place-kick, punt or drop-kick; players on the defense are forbidden to strike an opponent on the head, neck or face with hand, wrist, forearm or elbow; a player withdrawn from the game may re-enter once in any subsequent period; the flying block or tackle is forbidden; when any part of the ball carrier's body except his hands or feet touches the ground, the ball is "dead"; in equipment, hard substances must be padded with felt, foam rubber or other soft padding at least three-quarters of an inch thick. P. H. D.

FOOTE, ANDREW HULL (1806-63), American naval commander, was born at New Haven, Conn., Sept. 12, 1806. He entered the U.S. Navy in 1822, became a lieutenant in 1830, commander in 1849, and engaged in the suppression of African slave trade in 1849. In 1856 he was sent with the *Portsmouth* to East India Station to join the fleet of Commodore Armstrong. While establishing land forts at Canton, he was fired upon by the Barrier Forts, which he captured. During the Civil War he served with distinction, in command of the Southwestern naval forces, especially in the reduction of Fort Henry (Feb. 6, 1862), and the capture of Fort Donelson (Feb. 16), where he was wounded. On April 7 he captured Island No. 10 with General Pope. His wound, however, was giving him trouble and he was transferred to easier naval duties after promotion to the rank of rear-admiral. He died in New York City, June 26, 1863.

FOOTE, ARTHUR WILLIAM (1853-), American musician, was born at Salem, Mass., Mar. 5, 1853. With the exception of study with J. K. PAINE, he was largely self-taught. He composed in many forms, all his work being characterized by excellent workmanship. On Thanksgiving Day, 1914, organists throughout the United States played his *Festival March in F*, in celebration of his recovery from a serious illness.

FOOTINGS. See FOUNDATIONS.

FOOT-POUND. See WORK.

FOOT ROT, in sheep, a disease of the claws of the foot. It is the result of an infection by the *Bacillus necrophorus* and occurs most often in animals pastured in swampy land. Foot rot is spread by infected pastures, stables or direct contact. The chief symptom is lameness, the feet being swollen at the coronet and the horn rotten, the infection gradually spreading to include and destroy bones and tendons. The foot must be cleansed and the rotted horn removed and abscesses must be opened and properly bandaged to prevent reinfection.

FORAGE PLANTS, a group of plants that furnish food for cattle, especially certain GRASSES. While most forage is obtained by the grazing of animals, some valuable forage crops like alfalfa and corn are cut and stored for winter use. In tropical regions, where grasses are scarce, a few, like the guinea grass, are widely planted and cut, but never grazed as we use the forage plants of meadow or range. In other regions, notably parts of Mexico and Australia, various tree leaves are harvested for forage. The value of forage plants, apart from the highly nitrogenous legumes like alfalfa, the vetches and Japanese clover, consists in their providing necessary green constituents, without which few animals can develop. The cultivation of forage crops, either for harvesting or grazing is thus a feature of outstanding importance in agriculture. See SILO.

FORAKER, JOSEPH BENSON (1846-1917), American public official, was born near Rainsboro, O., July 5, 1846, and was brought up on a farm. In 1862, at the age of 16, he enlisted in the Union Army, being mustered out with the rank of brevet-captain in 1865. After attending Ohio Wesleyan college, he transferred to Cornell, graduated in 1869, entered politics as a Republican, and practiced law in his native State with distinguished success, becoming a judge of the Cincinnati Superior Court in 1878. From 1885 to 1889 he was Governor of Ohio, and from 1896 to 1909 United States Senator. During his two terms in the Senate he was recognized as a talented constitutional lawyer and as a leader of his party. He consistently opposed President Roosevelt's policies, particularly in connection with the passage of the Hepburn Act in 1906. Disclosures in 1908 that Foraker, while holding public office had been in the employ of the Standard Oil Co. compelled him to retire from public life. In 1914 an attempt to re-enter politics ended with his defeat by Warren G. Harding, his former political protégé, in the contest for the Republican senatorial nomination. He died May 10, 1917.

FORBES-ROBERTSON, SIR JOHNSTON (1853-), English actor, was born at London, Jan. 16, 1853. The son of a noted art critic, he studied painting at the Royal Academy. Attracted to the drama he learned elocution from Samuel Phelps, and began his professional career as Chastelard at the Princess Theatre in *Mary Stuart*. He played romantic parts with the Bancrofts, Irving, Wilson, Barrett, Modjeska, Hare and others, and came to America

first as Mary Anderson's leading man in *Thermidor*, 1895. He painted portraits of Ellen Terry, Modjeska and Gladstone, and published his reminiscences, *A Player Under Three Reigns*, in 1925. Forbes-Robertson began his farewell tour of America in 1913, just after his knighthood. Possessing one of the stage's most beautiful voices, he will be remembered for the spiritual quality of his acting, notably in *Hamlet* and *The Passing of the Third Floor Back*.

FORBIDDEN CITY, the city within the city, at Peiping, which was the residence of the Chinese emperors and their immediate attendants. After the establishment of the Chinese Republic in 1912, the last of the Manchu emperors was allowed to continue to live and maintain a semblance of a court in the northern part of the Forbidden City. In 1924, he and his family were ousted by the "Christian General" Feng Yu-hsiang. After the establishment of the Kuo-mintang government in 1928, the Forbidden City was made into a national museum, and a good deal has been done to restore the buildings and to preserve them from ruin.

FORCE. The defining equation of a force is $F = Ma$, where M is the mass of a body and a its acceleration.

In the **METRIC SYSTEM**, if a gram mass has an acceleration (*see* **VELOCITY**) of one cm. per sec. per sec. imparted to it, there will be a unit force acting upon it which is called the dyne (*see* **UNITS, PHYSICAL**). In the English system, the unit force is the poundal. It is the force which will impart to a pound mass an acceleration of one ft. per sec. per sec.

Among engineers, it is common practice to use the force with which the earth attracts a pound mass as the unit of force. This is equal to 32.2 poundals.

FORCE BILL. (1) An Act of Congress, Jan. 21, 1833, passed at President Jackson's request, authorizing the president to use the military and naval forces to resist interference with the collection of national revenues, and giving the courts of the United States jurisdiction in cases arising under the revenue laws. It was aimed especially at South Carolina. (*See* **NULLIFICATION CONTROVERSY**.) (2) A name applied derogatively by Southerners to any of several **RECONSTRUCTION** acts of Congress. (3) A bill introduced in 1890 by Representative H. C. LODGE for the supervision of Federal elections, providing that on petition of 500 voters in any local district Federal officials be appointed to the election boards. Its purpose was to prevent the illegal exclusion of Negroes from the polls in southern states. The Democrats opposed the bill strenuously and were able to prevent its passage in the Senate.

FORD, FORD MADOX (1873-), English writer originally named Ford Madox Hueffer, was born in London, in 1873, the grandson of Ford Madox Brown. He began to write when only 15, and at 22 had four books to his credit. He collaborated with JOSEPH CONRAD in writing *The Inheritors*, 1901, and *Romançe*, 1903. In 1908 he was one of the founders and, for a short time, an editor of *The English Review*.

In 1921 he published his résumé of the literary field, *Thus to Revisit*, and in 1924 his *Joseph Conrad*. He has published more than 60 books, among them, *A Man Could Stand Up*, 1926, one of four novels dealing with the World War.

FORD, HENRY (1863-), American manufacturer, was born at Greenfield, Mich., July 30, 1863. At 15 he became an apprentice to a machinist, and repaired watches at night. He then entered an engine shop, and later installed steam-engines on farms. As an engineer with the Detroit Edison Co., he experimented in his free time on a vehicle to be propelled by an **INTERNAL COMBUSTION ENGINE**. In 1892 he finished this machine, running it 1,000 miles, when he sold it and began constructing a lighter model. In 1899 he began as a motor-car manufacturer, building, in 1902, a 4-cylinder 80 horse-power car, which won every race in which it was entered. The following year Ford formed the Ford Motor Co., capitalized at \$100,000. During its first year, the company sold 1,708 2-cylinder, 8 horse-power cars. Ford searched for a stronger steel, and upon finding vanadium steel, he began production of the celebrated "Model T" touring car, selling at an unprecedented low price. By 1915 Ford had produced more than a million automobiles, and in 1926 was manufacturing two million cars annually. The price of the much improved touring-car was, by this time, considerably lower. The 200,000 employees were paid wages much above the average. This was made possible by Ford's developed methods of production combined with the enormous number of cars he sold annually. Ford established 35 assembly plants throughout the U.S. and factories were erected in several foreign countries. In 1914 he introduced a profit-sharing plan, by which part of his earnings were to be distributed to employees. In 1915 he chartered a ship and led a peace delegation to Europe. In 1919 Ford purchased the shares of the minority stockholders, thus gaining outright ownership of the company. Post-war competition forced the manufacturer to produce a new model, and in 1928 he ceased production of "Model T," which had a planetary transmission gear. The Ford plants were re-equipped to produce the new "Model A" Ford, which was given a more powerful engine, standard gear-shift, and was notably improved in design. The new model sold for only slightly more than its predecessor. In providing rural communities with cheap and rapid transportation, Ford's product has played a definite role in the social and economic development of the nation. In 1932 Ford introduced an eight-cylinder model of his car. The Ford Company also manufactures tractors and transport airplanes.

FORD, JOHN (1586-1640), English dramatist, was baptized Apr. 17, 1586, at Ilstington, Devonshire. A John Ford matriculated at Exeter College, Oxford, in 1601, who may have been the dramatist; he was admitted to the Middle Temple, 1602. He wrote *Fame's Memorial*, an elegy on the Duke of Devonshire, and was apparently at one time a court poet. He collaborated with THOMAS DEKKER in *The Fairy*

Knight and *The Bristowe Merchant*, 1624, and with JOHN WEBSTER in *A Late Murther of the Sonne upon the Mother*, 1624. Warburton's cook destroyed several of Ford's plays, but among those preserved are *'Tis Pity She's a Whore*, acted 1626, translated by Maeterlinck and produced in Paris, 1894, as *Annabella*, and *The Broken Heart*, acted 1629; both were printed in 1636 under the anagram, *Fide Honor*. Others are *The Lover's Melancholy*, acted in 1628 and published in 1629; *The Lady's Trial*, acted 1638, p. 1639; *Love's Sacrifice*, acted 1630, p. 1633; *Perkin Warbeck*, p. 1634, and *Fancies Chaste and Noble*. Ford collaborated with Dekker and Rowley in *The Witch of Edmonton*, a drama of great power. Nothing except the date, 1640, is known of his death. Ford was weak in comedy, but he excelled in depicting violent and unnatural passion.

FORD, PAUL LEICESTER (1865-1902), American author, was born in Brooklyn, N.Y., Mar. 23, 1865, and was educated privately. A student of early American history, he wrote biographies of several early statesmen, including George Washington and Benjamin Franklin, and edited the works of Thomas Jefferson. His reputation as a writer was made by his fiction, particularly *The Honorable Peter Stirling*, a novel of New York society, and *Janice Meredith*, 1899, a story of the American Revolution. Ford died in New York City, May 8, 1902.

FORD CITY, a borough in Armstrong Co., in western Pennsylvania, situated on the Allegheny River, 35 mi. northeast of Pittsburgh and served by the Pennsylvania Railroad. The important local industry is plate glass manufacture. Capt. J. B. Ford, for whom the city was named, built the first glass factory here in 1887. Pop. 1920, 5,605; 1930, 6,127.

FORDHAM, a part of the borough of The Bronx, Greater New York. It is situated on the east side of the Harlem River, 4 mi. north of Manhattan Island. Fordham is the seat of the Jesuit institution, Fordham University, founded in 1841 as St. John's College. A cottage in which Edgar Allan Poe lived and wrote *Annabel Lee*, is an interesting landmark of the section. Fordham was founded by the Dutch in 1669. In 1874 it was included in New York City.

FORDHAM UNIVERSITY, a Catholic institution, located in New York City. It was founded in 1841 as St. John's College in the old Dutch village of Fordham by Archbishop John Hughes, and the first class was graduated in 1846. After the first five years, during which the college was conducted by the diocesan clergy of New York, the control of the institution passed to the Society of Jesus. In 1907 the name was changed from St. John's College to Fordham University. The institution comprises schools of Law, Pharmacy, Social Service, Accountancy and Business Administration, and a Graduate School. Women students are admitted to the Social Service, Graduate and Law schools. The university has productive funds which amount to \$361,577.79. The library, which contains 110,000 volumes, includes

special collections of Greek and Latin Fathers, 350 volumes. In 1930-31, there were 10,121 students, and a faculty of 384 headed by the Rev. William J. Duane.

FORDNEY, JOSEPH WARREN (1853-), American congressman, was born at Blackford Co., Ind., Nov. 5, 1853. He had a common school education and lived on a farm until his 16th year, when he moved to Saginaw, Mich., and started work in the logging camps. In this occupation he obtained a broad knowledge of the lumber industry, in which he later acquired extensive interests. In 1899 he was sent to Congress, where he remained continuously until 1923. He was prominent in tariff legislation under President Harding, being the co-author of the Fordney-McCumber Bill, and serving on the House Committee on Foreign Affairs.

FORDNEY-MC CUMBER TARIFF ACT, in effect Sept. 22, 1922, a protective measure which purported to assess duties on a scientific basis equalizing the costs of domestic and foreign production (unsuccessful, because costs, fluctuating violently since the World War, were an unsafe gauge for calculation); which reflected the influence of an agricultural bloc determined to accord farmers the protection manufacturing interests commonly enjoyed; and which was designed to meet the need of revenue. Ad valorem rates corresponded on the average to those in the PAYNE-ALDRICH TARIFF. Nearly all rates on agricultural products were at the figure demanded by agricultural interests: wool, 31 cents a pound; wheat, 30 cents a bushel; sugar, 1.76 cents per pound on Cuban and 2.20 cents on that from other countries. The free list was drastically shortened. The act was in essence a party measure, receiving only three Democratic votes in the Senate, one from a wool-growing state, two from a sugar-producing state. The President was authorized to increase or decrease rates within a range of 50 per cent, subject somewhat to recommendations of the Tariff Commission.

FORECASTLE, the raised forward part of a vessel above the weather deck, in which are the crew's quarters. On the deck over the forecandle are located bits and chocks for handling the vessel, and also the anchor windlass.

FORECLOSURE, technically a proceeding in equity by which the right of a mortgagor to redeem the mortgaged property is terminated, and the property becomes that of the mortgagee absolutely. At common law a mortgage is a conveyance upon condition to become void in case the debt secured is paid, or act secured is performed at maturity. In case of default the property becomes absolutely that of the mortgagee. Equity, however, recognized a right of redemption in the mortgagor after default, and foreclosure was a means of terminating this right. It might be strict foreclosure, in which after a period prescribed in the decree the property becomes absolute in the mortgagee, or foreclosure by sale in which the mortgaged property is sold under order of the court and the proceeds applied to the debt. The

term is also applied to statutory proceedings in the several states, and to proceedings in equity to cut off the right of redemption under statutory liens.

FOREIGN EXCHANGE. A written order drawn by one person, firm or corporation, upon another, directing the latter to pay a sum of money to a designated party, if drawn in proper negotiable form is known at law as a bill of exchange. CHECKS and what are commonly called drafts, are examples. When these orders are payable in places relatively distant from the points where they are drawn or created, they are in banking (*see* BANKS AND BANKING) and mercantile usage classed as exchange. Exchange also includes telegraphic orders to pay money at distant points. Orders payable in a foreign country and currency are classed as foreign exchange; those payable within the country of origin as domestic exchange. There is much buying and selling of foreign exchange between merchants and banks, and also in an inner market between banks and banks. Definitions of foreign exchange as "the system of payment of debts between countries" or as "the price of the money of one country in terms of the money of another," are common but miss the mark. Exchange is an article that can be bought and sold, and consists of written and telegraphic orders to pay. The price payable in home money for a unit of foreign money payable on order, is the rate of exchange. The rate of exchange is not always quoted precisely in the form of this price, but whatever the manner of quotation it will always indicate what this price is. Exchange is the almost exclusive means of making payment on the countless individual commercial and financial accounts arising between different countries. The classes of exchange are so numerous, and the methods of handling it so varied, that a small number of illustrations can give only an inadequate idea of its nature and use. An exporter in Brazil might, to obtain MILREIS, draw at sight on his importer in Australia for a return 90 days draft on London, i.e., on a London bank, payable in English sterling. For simpler illustrations: Suppose D in the United States for some reason owes a person in England £100. D procures from an American bank its check for that amount of sterling money, a check drawn on a London correspondent with whom the drawing bank carries a balance or deposit. D is buying and the bank is selling foreign exchange; in this case bankers sight sterling. The banker charges D perhaps \$4.87¼ of United States money for each pound of the check; 4.87¼ is then the rate of exchange in the case, the over the counter selling rate for bankers sight sterling. Perhaps an American merchant M sells and ships to an English importer, goods priced at £5,000. By agreement M draws a draft on this importer requiring him to pay that sum of sterling 60 days after sight, i.e., after sight of the draft by the drawee to the order of the First National Bank of M's city. M induces this bank to buy this draft at say \$4.80 per pound. A parcel of exchange is then sold in this country for a consideration of \$24,000. Whether the

First National causes this draft to be discounted in London for immediate cash, or alternatively keeps ownership in it till maturity, as an investment in exchange, it realizes from it sooner or later sterling funds in England. These it reconverts at its pleasure into American funds either by the sale of sterling exchange on the American side or the purchase of dollar exchange on the English side. An exporter in any country may draw a sight or time draft upon a bank in the importing or in a third country, instead of upon the importer himself, under an arrangement known as a commercial credit.

In general the principal original supplies of foreign exchange in any given country come from those who have exported merchandise or securities to foreign countries, or have sold services abroad, or who hold foreign investments; in a word from those who have become creditors of foreigners. The chief demand comes from those reversely circumstanced at home, importers of goods or securities, buyers of foreign services or borrowers of foreign capital. Immigrants and travelers also enter the market for exchange. Between the classes responsible for the original supply and original demand, the banks act as indispensable middlemen, taking relatively small profits and commissions for their services. *See* GOLD POINTS; PURCHASING POWER PARITIES.

A. C. W.

FOREIGN EXCHANGE AND CENTRAL BANKS. Before the World War, the relation of foreign exchange to central bank policy arose from the fact that the central bank was held responsible for the gold reserves of the banking system, and that when exchange rates moved to a point where gold was likely to be exported, it became the duty of the central bank to step in, raise its discount rate, or otherwise interfere to protect its gold. The Bank of England developed this technique, and was generally followed by other central banks. Since the war, the Bank of France and the Reichsbank have held part of their required reserve as foreign bills drawn in currencies on a gold basis. These *devisen* in the portfolios of the central banks form the principal reserves of countries on the gold exchange standard. In India, for example, the reserves are in the form of sterling bills; in Rumania, in the form of French bills and deposits with the Bank of France.

B. H. B.

FOREIGN INVESTMENT. *See* CAPITAL, EXPORT OF.

FOREIGN MISSIONS OF PARIS, SOCIETY OF, an association of secular priests in the service of the missions. Founded in 1658 by Mgr. Pallu and Mgr. Motte-Lambert, Vicars-apostolic of Tonking and Cochin-China, it was the fulfillment of an earlier project of the missionary, Alexander of Rhodes, in 1653. At that time Portugal's hostility to French advancement prevented the departure of candidates for Eastern missions. A seminary established in Paris in 1663 is the recruiting and administration center of the Foreign Missions. Three years' experience in the mission field is required of prospective members,

who must pledge themselves to lifelong service in missionary work. At present nearly 1,100 members, including 46 bishops, and assisted by more than 1,400 native priests, conduct 37 missions in Japan, Korea, China, Tibet, Indo-China, Siam and India.

FOREIGN SERVICE. See STATE, DEPARTMENT OF.

FOREIGN SETTLEMENTS (IN CHINA), tracts of land at the various TREATY PORTS of China set apart by the Chinese government within which foreigners may reside, lease land and, normally, establish and control local administrative agencies. These areas are frequently called CONCESSIONS, the term being used interchangeably with settlements. Since the rise of Chinese nationalism several of the concessions have been terminated, or modified to permit the participation of Chinese in the local government and administration.

FOREIGN TRADE, the interchange of commodities between nations just as domestic trade is exchange within a nation. Foreign trade does not differ fundamentally from domestic trade. Like all trade it is one aspect of the territorial division of labor. The existence of international boundary lines, however, does involve some sharp differences in detail. Chief of these differences arises from the fact that international boundaries retard the movement of CAPITAL and LABOR from one country to another. The result is more or less permanent differences between countries in the effectiveness of capital and labor. Foreign trade differs from domestic trade also in that it is frequently carried on between peoples of widely varying habits, tastes, social customs, legal concepts, currency systems and languages and because of the rigid legal restrictions that may be imposed on the movement of goods into and out of a country.

Foreign trade rests upon two fundamental principles: that imports and exports, including services, must in the long run be equal; and that the quantity and kind of goods entering into trade rest on the principle of comparative advantage. IMPORTS AND EXPORTS must in the long run be equal because one must make payment for the other. The immediate payment is made on a CREDIT basis through the use of drafts (see BILL OF EXCHANGE) just as in domestic trade it is made through the use of bank CHECKS. But these drafts actually convey no funds from one country to another and can be used only so long as the drafts calling for payments out of a country are equal to those calling for payments to that country. If they are not equal then GOLD or other precious metal must be shipped. But the quantity of gold that a given country can use to purchase imports is limited. The quantity even that a country should receive also has its limits. In the long run, therefore, the only way in which the claims on a country arising from its imports can be cancelled is by the creation of similar claims on foreign countries which, in turn, can be secured only through exports.

The principle of comparative advantage as usually expressed states that the particular commodities ex-

ported from a country are those in the production of which it has the greatest comparative advantage or least comparative disadvantage. Suppose that the effectiveness of the agents of production in England were such that the cost of producing article A is to the cost of producing article B as 2 is to 3. In the United States, however, the costs are the same. If the cost of both were lower in the United States than in England, both would be exported to England; gold would flow from England to the United States and costs here would rise while in England they would fall. If costs were higher in the United States than in England, the reverse would happen. In either case the price and cost of article A would become less in England than in the United States while the cost of article B would be lower in the latter country. When this happened, England would export article A while the United States would export article B. Equilibrium would then be established. A country that is generally superior to other countries will export those commodities in the production of which its superiority is the greatest while a country that is generally inferior to others will export those commodities in which its inferiority is the least. A generally high or low effectiveness of labor and capital will not prohibit a country from engaging in trade because its price level will be adjusted to that situation. A. F. L.

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FOREORDINATION. See FREE WILL.

FOREST CANTONS. The three villages of Uri, Schwyz and Unterwalden, on the border of the old Duchy of Swabia, claimed independence of any power but the emperor's. In 1291 these villages, or cantons, formed a League for mutual aid against threatened HABSBUURG oppression. In 1318 the Hapsburgs concluded a treaty with them renouncing all claims to administrative authority within the League's boundaries. In 1330 Lucerne joined the League, which formed the nucleus of modern Switzerland.

FOREST CITY, a borough in Susquehanna Co., northeastern Pennsylvania, situated 24 mi. northeast of Scranton in the Moosic Mountains and served by three railroads. This region is good farming country; anthracite coal-mining is the leading industry. The city has women's clothing factories. Forest City was incorporated in 1888. Pop. 1920, 6,004; 1930, 5,209.

FORESTER, a forest manager or administrator; a practitioner of the profession of forestry, i.e., the establishment, maintenance and utilization of forests, whether for growing and harvesting crops of wood and other products, for protecting watersheds and regulating stream-flow, for recreational use and scenic embellishment, or for other contributions to social and personal welfare; a person engaged in forestry education or research; loosely, anyone employed in caring for or exploiting forests.

FORESTERS, ORDERS OF, a group of fraternal and beneficial societies of which there are three important, separate orders in the United States and

affiliations in more than 30 countries. The parent organization, the *Ancient Order of Foresters*, was founded in Yorkshire, England, in 1745. Its policy was based on the highest traditions of the English royal forests and the Robin Hood tales. An American society, or "Court Good Speed" was chartered in Philadelphia in 1832, and since then, "courts" have spread rapidly throughout the United States and Canada.

In 1874 there was a secession of several groups who formed the *Independent Order of Foresters* at Newark, N. J. This society now has branches in Europe, India and Australia, besides a membership of more than 140,000 in the United States. Local courts transact the business of individual organizations but the highest power is vested in the Supreme Court which is administered by delegates from each country. Women are admitted to membership by the Miriam degree.

Another split occurred in 1899, when the *Ancient Order of Foresters of America* withdrew from the original English order. Its organization into courts is similar to that of the other orders. The membership is above 200,000. Women members have formed circles of "Companions of the Forest." All of these orders distribute benefits amounting to many millions of dollars yearly.

FOREST HILLS, a residential suburb in Queens Borough, Greater New York. It is situated 5 mi. east of Brooklyn and is served by the Long Island Railroad. Forest Hills has a fine tennis stadium, and the Davis Cup International Tennis Matches and national matches are held here.

FOREST NEGRO. See RACES OF MANKIND: *Negroid Group*.

FOREST PARK, a city and residential suburb in Cook Co., northeastern Illinois, situated on the Desplaines River, 12 mi. west of Chicago. It is served by three railroads. Forest Park is mainly residential, but it has several factories producing chiefly cedar chests, monuments and office equipment. There are also planing mills and greenhouses. In 1929 the total manufactures amounted approximately to \$4,000,000; the retail trade was valued at \$7,246,014. Located here are St. John's Lutheran Church, organized in 1879, and Altenheim, a home for aged Germans. Forest Home Cemetery is the site of a former Indian village and burying ground, probably of the Weanamee and Pottawattomi tribes. Numerous trails traversed this region, from which Indian relics have been unearthed and assembled in the office of the cemetery. Forest Park was settled in 1851; incorporated in 1884. The predominating nationality is German. Pop. 1920, 10,768; 1930, 14,555.

FORESTRY. See FORESTS AND FORESTRY.

FORESTS AND FORESTRY. Although difficult to define, a forest may be said to be an area of land covered with shrubs and trees which is of economic importance because of (a) the value of its products, and (b) its biological influence. Probably at some time all dry land of the continents as now

constituted was forest-covered. But now, largely due to man's destructiveness, but also because of climatic changes, whole areas of former forest lands are marshes, grass land, steppe, or desert.

There are four recognized great forest regions of the world: those of conifers, of temperate zone hardwoods, of mixed hardwoods and conifers, and of tropical hardwoods. The present forest area of the world is estimated at 7½ billion acres, covering 29% of the total land area. Of this forest land, 28% is in Asia, 20% in North America, 37% in South America, 11% in Africa, and 4% in Australia and Oceanica. In the world as a whole, conifers occupy 25% of the forest areas, temperate hardwoods 16% and tropical hardwoods 49%. Almost half of the world's forest area is covered by tropical hardwoods in lands containing a very small per cent of the world's population.

Forests have been and are of the greatest importance to mankind. Their direct utility is due chiefly to their products, which include timber, firewood, charcoal, woodpulp for paper, tanning materials, dyestuffs, rubber and such naval stores as turpentine, pitch and rosin. Their indirect value lies chiefly in their effect on climate, stream flow and soil erosion. Water is sucked up by tree roots and carried to the leaves by the sapwood just underneath the bark. A large, broad-leaved tree such as an oak may give off as much as 150 gals. of water in 24 hours. Thus a dry wind passing over a forest takes up as much water as when passing over a lake. This also explains why a forest greatly lowers the temperature of the air above it and also that of the soil, which will be 2° warmer in winter and 5° colder in summer than that immediately outside the forest. Forest humidity is always from 4 to 12° greater than outside. That forests assist in producing moisture is easily proved by comparing the rainfall of treeless and forested countries.

Forests particularly influence the flow of streams. Branches and leaves break the force of rain, and part of the downpour is caught by the leaves, while a great deal is absorbed by the soft ground cover of leaves and loose earth. Tree roots bind the soil in all directions, preventing its being washed away. Snow remains unmelted beneath the trees much longer than outside the forest, so that its water does not run off into brooks until after that of the early rains has been carried to streams and reservoirs. Forests drain lowlands and marshes and prevent the formation of stagnant swamps. The terrible effects of deforestation are seen especially in China, denuded of trees for centuries, where the climate has greatly changed, rainfall has lessened and frequent disastrous floods have caused famines and millions of deaths.

The forests of all civilized countries have been decimated, the bulk of this destruction taking place since the 18th century. Primitive man could not fell large trees in any number and his migrations were constantly limited by forests. The Roman Empire halted when it reached the great German forests,

which also barred the onward march of the Huns, Avars and other raiders from the east. The forests of Europe, when the growth of nations made agricultural expansion necessary, were cleared only through the efforts of religious orders and by the resources of great rulers. The work, however, was so thoroughly done that Europe has suffered for centuries as a result. Between 80 and 90% of the forests of Europe are gone, and 95% in Great Britain. Less than half of the Scandinavian forests remain, and Russia alone possesses tracts of virgin timber. Thirty-two per cent of the land area of Canada is forest, a third being of commercial value, while the United States has but a sixth of its original forests.

The United States divides naturally into three vegetation regions. From the Atlantic coast to the Mississippi stretched originally one great forest. From the Mississippi to the Rockies was grassland, while the western third of the country was forest except for lowland stretches of desert. Now the only large forests of big timber are those of the Pacific coast, especially in Washington, Oregon and Idaho. These areas were quite unlike, the eastern forests consisting largely of broadleaved trees while the western forests, principally soft woods, contain over twice as many conifers as the eastern forests. The two areas have been sub-divided into five sections: in the east, the northeastern, central and southern forests; in the west, the Rocky Mountain and Pacific Coast forests.

Once the most important in the country, the northeastern forest is almost entirely gone. It contained more soft than hardwoods, especially white pine and red spruce. On the more fertile lands, hardwoods such as beech, maple and birch predominate. Much of the original pine has been replaced by second growth poplar, birch and aspen, of little value except for pulp. Of the central forest, largely hardwood, not more than 5% remains. This section is now valuable farmland. The southern forest contains hard and soft woods with yellow pine predominating to furnish both valuable timber and naval stores. Here growth is rapid and reforestation will pay good dividends. There remain 23,500,000 out of 130 million former acres. Thirty million acres need replanting.

The Rocky Mountain forest has suffered less from logging than from fires. Half of the virgin timber remains, the most important species being yellow pine, although other valuable conifers are numerous. This section consists of islands of forest on mountains rising from desert lowlands. The Pacific Coast forest, largest of the country, is composed almost entirely of conifers, the gigantic Douglas Fir being the principal tree. There are large stands of yellow pine and western hemlock. The redwood here is an important and valuable tree. This is now the greatest timber-producing section of the country, but the enormous cutting threatens rapid exhaustion.

Two great national forests in Alaska contain 20,579,740 acres or over 5% of the land area. The larger, the Tongass National Forest, is said to contain 70 billion board feet of timber now ripe for selling.

Stands of 100,000 ft. to the acre are common. This forest has a coastline of 12,000 mi.; none of the timber is more than 2 mi. from water. The Chugach National Forest contains about seven billion feet of merchantable timber. Together these forests contain 100 million cords of pulpwood and could ship 2,000,000 cords a year, one-third of the United States requirement, for centuries without depletion. These forests have waters yielding over 250,000 horse-power.

While five-sixths of the United States forests have been cut, most of this has been done during the last century. It took 200 years for early settlers to reach the crest of the Appalachians. When the colonies were first settled the forests of the United States, the richest of the world, covered about 822 million acres, of which many millions were so thoroughly cut that to-day they contain neither timber nor young growth. As early as 1626, Plymouth Colony passed a law that no timber should be cut without official permission, and William Penn ruled that his colonists should leave one acre of forest for each five cleared. These were the first forest conservation laws passed. In 1877 Congress appropriated \$200,000 to purchase a small forest as a source of naval supply, and in 1827 the first actual Government work in forestry was started with an attempt to raise liveoak in the south to provide navy ship-timbers. In 1881 a Division of Forestry was organized in the Department of Agriculture, and in 1891 President Harrison created the first forest preserve, the Yellowstone Park Timberland Preserve. By the end of the administration of President McKinley, 30 million acres had been set aside. President Roosevelt brought this total to 150 million acres. The United States Forest Service has grown rapidly since 1898 and now employs more than 3,000 permanent workers and several thousands temporarily during the forest fire season. In 1930, the National Forests numbered over 150, covering 160,090,817 acres, 340,000 of which were added in 1930. For administration purposes, nine forest districts have been established, one of which covers Alaska.

During the last few years especial attention has been given to the Appalachian watershed, where cutting of trees has seriously affected the streams from which many large eastern cities draw their supplies for drinking and for waterpower. National forests have been started in the White Mountains of New Hampshire, in the Ozarks and in the Appalachian Mountains of the southern states. Another is the Superior National Forest of Minnesota, which contains 1,250,000 acres, including 150,000 acres of lakes visited by thousands annually.

All national forests have been surveyed and lands more suitable for farming than for forestry excluded. It is estimated that these national forests contain 500 billion ft. of commercial timber or nearly 25% of the merchantable timber remaining in the country. Over one billion board feet are sold annually, the proceeds helping support the Forest Service. Other income comes from grazing permits. Many

of the forests contain large areas of grassland which when dry are constant fire threats unless the grass is kept down. Some 9,500,000 animals, including over a fifth of the cattle and half of the western sheep, graze in national forests. The fee is at the rate of \$1.20 per year for cattle, \$1.50 for horses, \$.90 for hogs and \$.30 for sheep. In 1930 the receipts from grazing, the sale of timber, rental of waterpower and other sources was \$6,751,553.

Each forest district has a district forester, with headquarters usually in the most important city of his territory. His staff includes experts in lumbering, grazing, fire protection and other activities. Each forest in the district has a forest supervisor, beneath whom is a corps of forest rangers, each in charge of a district. Forest rangers watch their districts for fire, build trails and roads, check grazing permits, string telephone lines, make maps, and enforce forest and game laws. A ranger may have one or more assistants, and may arrange for other help in checking fires. Up to 1931, over 25,000 miles of road and 35,000 miles of trails have been built by rangers in the various national forests, and 125,000 acres have been replanted with seedlings or reseeded. Over 5,500,000 citizens visit the national forests each year. Forest rangers are also responsible for fighting the various insect enemies and conquering the many diseases that attack the trees.

Of the diseases, the chestnut blight is perhaps best known, since it has almost totally exterminated this tree. The white pine blister is killing thousands of trees, but may be controlled, since in one stage of its development it infests currant and gooseberry bushes. If these are killed the blister can be controlled. The bark beetle is a most dangerous insect enemy and on the northwest coast does enormous damage.

The Forestry School of Yale University was one of the first in the country. By 1930 there were 22 forestry schools in the United States.

In 1880, New Hampshire appointed a commission to work out a state forest policy; Vermont followed two years later. In 1885, New York created a Forestry Department, providing liberal funds to buy state lands, which now cover 2,000,000 acres. Since this land is held strictly as a game and camping preserve, cutting timber is forbidden. The Pennsylvania Forestry Department, started in 1895, now has 1,250,000 acres, managed primarily for timber production. Wisconsin has 400,000 acres of state forest; Minnesota, 330,000; Michigan, 200,000.

The entire country has only 4,237,587 acres of state-owned forest land, or 1½% of the cut-over and denuded land suitable for replanting. Eighty million waste acres, suitable only for trees, could be made productive, but lack of funds greatly limits this work. Some states have tree nurseries, planting many seedlings and giving more away to be planted. A. R. F.

FOREST SERVICE, under the Department of Agriculture, is charged with the duty of promoting efficient methods of raising and using the product of public and of privately-owned forest lands. A most

important phase of its work is the administration of the national forests, which contain 159,000,000 acres or one-fourth of the timber of the United States, besides forage and recreational resources. Information is disseminated by the Forest Service on technical methods of forestry, particularly on means of sustaining or increasing the timber yield and on conservation of ranges through livestock grazing. Watersheds are protected and developed for the sake of power and irrigation projects, and municipal supplies. In cooperation with the states, the Forest Service provides a systematic protection against fire. It distributes planting-stock to farmers for windbreaks and farm woodlands. Research activities include investigations of forest taxation and economics as well as of the uses of forests and forest products. The personnel includes a chief forester and associate forester, a chief of finance and accounts and special assistant foresters for each branch of the service—forest management, range management, engineering, public relations, etc. S. C. W.

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FORGAN, JAMES BERWICK (1852-1924), American financier, was born in St. Andrews, Scotland, Apr. 11, 1852. After finishing school he was employed successively by banks in Scotland, Canada and Nova Scotia until 1888 when he became manager and cashier of a bank in Minneapolis. In 1892 he went to Chicago as vice-president of the First National bank and in 1900 became its president. Forgan served five years as director of the Federal Reserve Bank of Chicago, and six years with the Federal Reserve Board, Washington. He died at Chicago, Oct. 28, 1924.

FORGERY, falsely making or materially altering a writing which, if genuine, would have some legal efficacy, done with intent to defraud.

FORGET-ME-NOT, the common name given to a genus (*Myosotis*) of beautiful plants of the borage family, called also scorpion-grass, several of which are highly prized as garden ornamentals. There are about 40 species inhabiting moist soils in both the north and the south temperate zones, about 10 of which occur in the United States and Canada. They are low, branching, somewhat hairy herbs with small entire leaves and dainty blue, pink, or white flowers borne in partly coiled clusters. The true forget-me-not (*M. scorpioides*), which bears bright blue flowers with a yellow eye, is a native of Europe, now widely naturalized in North America.

FORGING, the kneading and refining of the coarse crystals and welding together of the surfaces of voids and discontinuities which exist in cast metal, thus producing greater strength and dependability. Small intricately shaped forgings are made from rolled or forged stock by a few blows under a drop-hammer, and less intricately shaped pieces by pressure in a forging machine. By numerous blows under a steam-hammer relatively simple sections are forged. Large masses are worked under an hydraulic press. Depending on the composition of the steel, the physi-

cal properties desired and the mass, forgings may vary from a few ounces to over 450,000 lbs. Besides steel, alloys of copper and other metals may be readily forged. *See also* DROP FORGINGS. F. B. F.

FORLÌ, a city of Italy, in the north-central part of the peninsula, capital of the province of the same name. It is on the railway between Bologna and Ancona. The ancient Via Æmilia traverses the length of the city, which is still walled. The fine marketplace is surrounded by colonnades and contains the 14th century Palazzo Communale. Noteworthy also are the Church of San Mercuriale with its huge, impressive campanile, the rebuilt cathedral and other churches, the 14th century citadel, municipal library and a museum with rare collections. There is diversified industry and brisk trade. Called by the Romans *Forum Livii*, the city became Papal in the 8th century, was in the Middle Ages an independent republic and was finally incorporated into the PAPAL STATES. Forlì participated in the revolutions of 1831 and 1848. Pop. 1931, 60,824.

FORMALDEHYDE, a colorless gas of stifling odor (formula CH_2O). It is formed, with generation of heat, when methanol or wood alcohol (*see* ALCOHOLS) vapors and air are passed over copper or other suitable catalyzer. Commercial FORMALIN is an aqueous solution containing about 37% by weight of formaldehyde.

Formaldehyde is a powerful germicide and is much used as a disinfectant, and as a preventive of "rust" in wheat and corn, by treatment of the seed before planting. It tends to combine with itself or polymerize (*see* POLYMERIZATION), giving solid forms, the best known of which is paraformaldehyde, $(\text{CH}_2\text{O})_n$. Also it combines with ammonia to form hexamethylene-tetramine, or "hexa," $(\text{CH}_2)_6\text{N}_4$.

Formaldehyde condenses with certain organic compounds, notably phenols and urea, to form products known as SYNTHETIC RESINS. This is at present its largest industrial use. L. V. R.

FORMALIN, a commercial name given to solutions of FORMALDEHYDE. It is used as an antiseptic, disinfectant, and also to preserve anatomical specimens. Another use is in photography for making the gelatine film insoluble.

FORMIC ACID, a fuming liquid with an irritating odor, (formula CH_2O_2), the simplest of the fatty acids of organic chemistry. It solidifies at low temperatures to form crystals that melt at 8.3°C . Formic acid is a powerful antiseptic and reducing agent. *See also* FATTY ACIDS.

FORMOSA or *Taiwan*, an island in the western Pacific Ocean separated from the coast of China by the Formosa Strait, 90 mi. to 220 mi. wide. The oval shaped island is about 225 mi. in length; the breadth varies from 60 to 80; the total area is 13,892 sq. mi. Pop. 1930, 4,524,161, including 211,202 Japanese and 40,364 foreigners, the remainder being Chinese and aborigines. The chief towns are Taihoku, Tainan, Kurun and Taichu. The aborigines belong to about nine different tribes, all ethnologi-

cally allied to the Malays. They are grouped roughly into northern tribes and southern tribes. The former are savage head hunters still far from being completely settled by Japanese administration, the latter are more submissive and civilized.

The island is traversed from north to south by a great range of mountains which divides it into two parts, east and west. Among the peaks on the east are Mount Niiitaka rising to 14,500 ft.; Mount Sylvia to nearly 13,000 ft. The volcanic peak Dalton, 3,630 ft., lies in the north with numerous hot springs in its vicinity. The western half is, by comparison, flat, fertile and generally well cultivated. The natural vegetation of Formosa is tropical forest of conifers and hardwoods. Bamboos flourish, and special interest attaches to the camphor trees. The manufacture of camphor and camphor oil is licensed by the government. The island is rich in minerals, including coal, gold, copper, petroleum, sulphur and phosphorus. Agriculturally, Formosa is important to Japan in two ways. Rice is grown in excess of requirements and hence there is a surplus available for export to Japan. In the second place tropical crops, notably sugar cane, which can scarcely be grown in Japan proper, flourish in Formosa. The "Oolong" tea cultivated is famous for its delicacy of flavor. Jute and ramie, or China grass, are promising crops. The heavy rainfall from the summer monsoon in the mountains results in autumn floods which are often serious.

Japan secured control of Formosa from the Chinese as a result of the SINO-JAPANESE WAR, 1894-95. Prior to that the Dutch had held the island for a time in the 17th century, and Spanish and other foreign navigators had landed on the coasts.

FORMOSUS, pope from 891-896, crowned Lambert of Spoleto coemperor in 892, but invited the German King Arnulf to Rome and crowned him emperor in 896, dying a few weeks later. His second successor, Stephen VI, a partisan of Lambert, had his body exhumed and thrown in the Tiber after posthumous excommunication. But Stephen was deposed and slain soon after, and his second successor caused Formosus's body, which had been taken from the river and secretly buried, to be interred in St. Peter's.

FORMS. *See* OFFICE MANAGEMENT.

FORMS OF ADDRESS. *See* ADDRESS, FORMS OF.

FORMULA, a relationship between magnitudes expressed in terms of mathematical symbols. For example, the formula for compound interest is $I = P(1 + r)^t$. Although $P(1 + r)^t$ is the formula for I , it is usual in America to speak of the equation as the formula. The ability to use formulas is the essential feature of ALGEBRA.

FORMULAE, CHEMICAL. *See* CHEMICAL FORMULAE OR FORMULAS.

FORNAX (gen. *Fornacis*), the furnace, a small constellation wedged in between Cetus and Eridanus, containing but one bright star of the third magnitude. *See* STAR: map.

FORNER, JUAN PABLO (1756-97), Spanish satirical writer, was born at Merida, Feb. 23, 1756. He studied at Salamanca, and went to Madrid in 1783, where he filled many high judicial posts. A born controversialist, he was among the severest critics of the 18th century. His passion for polemics led to violent attacks, not only on other authors, but even on their entire families. Forner was the author of *El Asno Erudito*, 1782. He died at Madrid, Mar. 17, 1797.

FORREST, EDWIN (1806-72), American actor, was born at Philadelphia, Pa., Mar. 9, 1806. His first performance was at 14 as Young Norval in *Douglas*, at the Walnut Street Theatre, Philadelphia. Immediately successful, he toured in *The Soldier's Daughter*, and at New Orleans, La., played in *Venice Preserved*. At the Bowery Theatre, New York City, he played *William Tell* and *Marc Antony*, and *Spartacus* and *Metamora* at the Park Theatre. He played his greatest part, *Lear*, in 1836. In London in 1836 he opened in *The Gladiator*, subsequently playing *Othello*, *Lear* and *Macbeth*. When his *Macbeth* met with disapproval in London, he attributed its failure to W. C. Macready's intrigues. Their quarrel led to the fatal Astor Place riots in New York City, May 10, 1849. Forrest accumulated a great fortune. He bequeathed to aged actors a home at Holmesburg, Pa. He died at Philadelphia, Pa., Dec. 12, 1872.

BIBLIOGRAPHY.—M. J. Moses, *The Fabulous Forrest*, 1929.

FORST, a Prussian city of Brandenburg, situated on the Neisse River about 63 mi. northeast of Dresden. It has important textile, buckskin and horsehair industries. Mentioned in 1350, it was held by several nobles, fell to the elector of Saxony in 1740 and to Prussia in 1815. Pop. 1925, 35,864.

FORSTER, JOHN (1812-76), English biographer, was born at Newcastle-on-Tyne, Apr. 2, 1812. He was educated at London University and entered the field of journalism. His earlier writings appeared in various periodicals, and after acting as literary critic for *The Examiner*, he became its editor in 1847. His first successful work was the *Treatise on the Popular Progress in English History*, 1840. Forster knew intimately the leading writers of his time. His crowning achievement was the *Life of Charles Dickens*, 1872-74. Other publications are *Life and Times of Oliver Goldsmith*, 1848, and *Life of Swift*, 1875. Forster died in London, Feb. 2, 1876.

FORSYTE SAGA, THE, a novel in the form of a trilogy, with two interludes, by John Galsworthy; published 1922. It reflects the manners and morals of Victorian and Edwardian England through the various members of an upper middle class family, the Forsytes. The second well-to-do generation of the Forsytes consists of the ten children of "Superior Dossett" Forsyte, the most important of whom are "Old Jolyon" and James. The chief character, however, is the son of James, Soames Forsyte. A sequel, *A Modern Comedy*, was published in 1930.

FORSYTHIA, a genus of deciduous shrubs of the olive family, closely allied to the lilac, jessamine, and

privet. There are four species native to eastern Asia and southeastern Europe, all cultivated for their showy yellow flowers which appear in great numbers much earlier than the leaves. The common golden bells (*F. suspensa*), a native of China, grows about 8 ft. high, with gray slender branches which become pendulous and often take root at the ends. The green golden bells (*F. viridissima*) also native to China, is a larger, more erect shrub with olive green branches.

FORT, PAUL (1872-), French poet, was born at Rheims, Feb. 1, 1872. He was always a follower of the Symbolist movement. His rhythmic poems, not exactly verse, but far beyond prose, seem a fulfillment of Baudelaire's longed-for "prose poem." The Théâtre des Arts, where Fort produced his own works, was founded and directed by him, 1890-93. He wrote for the *Mercur de France*, and edited a symbolistic organ, *Vers et Prose*, 1905-14. In 1912 he was elected "Prince des Poetes." *Ballades françaises* is a collection of his poems in 30 volumes. His play, *Louis XI, curieux homme*, is outstanding.

FORT, a self-contained fortification, either isolated or one of a chain, designed for the defense of a locality. The classic type consisted of a wall backed by a rampart, a ditch and a glacis outside the ditch. Behind the glacis was a covered way for lateral communication. The trace was polygonal, with bastions at the angles to sweep the fronts of the curtain walls, and often with various outworks. The artillery armament was in barbette on the ramparts or in casemates at lower levels. By reason of the increasing power of artillery in the attack, the present tendency is toward smaller and simpler works with guns protected by armor. See also SIEGE OPERATION.

FORTALEZA, or **CEARÁ**, a city of Brazil and capital of the state of Ceará, situated on the northeast coast of the republic, about 350 mi. northwest of Pernambuco. The climate is warm and dry. Fortaleza's harbor is a wide dangerous roadbed, and ships must anchor at sea. The city has a high school, an Episcopal seminary, government buildings, numerous churches and a bishop's palace. The products of the surrounding district, which are exported from here, are sugar, cotton, rubber, vegetables and fruits. Fortaleza became a city in 1823. Pop. 1920, 78,536; est. pop. 1930, 98,848.

FORT ANNE, a Canadian national historic park established Jan. 24, 1917, area 31 acres, in the province of Nova Scotia. It is situated in Annapolis Royal, settled in 1605 and the oldest European settlement in America north of the Gulf of Mexico. For a period of approximately 150 years Fort Anne was a center of rival French and British activity and its history is an almost continuous record of attack, capture and recapture. The fort contains many historic relics from colonial times.

FORT ATKINSON, a city in Jefferson Co., southeastern Wisconsin, situated on the Rock River, 48 mi. southwest of Milwaukee. The Chicago and Northwestern Railroad serves the city. The industrial activities include the manufacture of dairy and

barn equipment, knitted goods, and canned products. Fort Atkinson also has creameries, foundries and machine shops. Pop. 1920, 4,915; 1930, 5,793.

FORT COLLINS, a city of northern Colorado, the county seat of Larimer Co., situated 65 mi. north of Denver. It is served by the Union Pacific and the Colorado and Southern railroads. Agriculture, by irrigation, and stock raising are characteristic of the region. The local industries include a beet-sugar factory, milling plants, and cheese, cement, brick and tile factories. The retail trade in 1929 amounted to \$7,684,978. The Government maintains an experimental station here in conjunction with the State Agricultural College. Fort Collins is the gateway to Estes Park, and is on Poudre Canyon Highway, leading to Medicine Bow Area. Pop. 1920, 8,755; 1930, 11,489.

FORT DEARBORN MASSACRE, Aug. 15, 1812, a tragedy of the WAR OF 1812. Capt. Heald, commanding the garrison of 57 troops at Ft. Dearborn (the present site of Chicago), on Aug. 7 received orders from Gen. Hull at Detroit announcing the declaration of war and the invasion of Canada, and directing the surrender of the fort, if practicable, and, as a peace offering, the distribution of all United States property in the vicinity to the Indians. The tribes about Ft. Dearborn, Potawatami and Winnebago, had been subverted by the British. The garrison seems to have been well aware of the hostility; but Heald preferred to follow the order to evacuate. Accompanying the garrison were all the white inhabitants of the post, John Kinzie and family, wives and children of the soldiers, and several families of voyageurs. Ambushed in the sand dunes, 500 Indians attacked the party on its line of march. In a brief conflict, two-thirds of the whites were slain, and the remainder surrendered with the understanding that they should be ransomed as soon as possible. The wounded captives, however, were slain.

FORT DODGE, a city in northwestern central Iowa, the county seat of Webster Co., situated 91 mi. northwest of Des Moines, on the Des Moines River. Four railroads, airplanes and bus lines afford transportation. The region has gypsum, coal and clay deposits, and the principal industries of the city are the manufacture of gypsum and clay products. In 1929 the factory output reached an approximate total of \$5,000,000; the retail trade amounted to \$14,769,072. Grain is the chief crop of the vicinity. The site of Fort Dodge was settled about 1847. A fort, called Ft. Clark, was erected in 1850 to protect the colony from the Indians. The settlement was renamed Fort Dodge in 1857. The famous Cardiff Giant, carved out of gypsum, once considered a petrified man, was "discovered" near by. Fort Dodge was chartered as a city in 1869. Dolliver Memorial State Park lies 14 mi. southeast. Pop. 1920, 19,347; 1930, 21,895.

FORT DONELSON, BATTLE OF, Feb. 13-16, 1862, an engagement of the CIVIL WAR which resulted in the first important victory of the Federal army. Having taken Ft. Henry (*see* FORT HENRY, BATTLE

OF), Gen. Grant and Flag-Officer Foote advanced upon Ft. Donelson on the Cumberland River, Foote's gunboats sailing down the Tennessee and up the Cumberland while Grant marched overland to Donelson. The fort was excellently situated and strongly fortified, being occupied by 18,000 men under Generals Floyd, Pillow and Buckner. Grant's force numbered 27,000 men, under the division commanders Generals McClelland, Wallace and C. F. Smith. On the 13th McClelland prematurely directed an advance on the Confederate earthworks; but his troops were repulsed with great loss, Morrison being among the fatalities. On the 14th the gunboats opened a cannonade, returned by the Confederate batteries with spirit; Foote was severely wounded, and the day's engagement ended indecisively. Meanwhile the full strength of Grant's army arrived. Early on the 15th the Confederates made a desperate sortie from the fort. McClelland's division was driven back in confusion, whereupon Grant assumed active command and ultimately drove the enemy back within the entrenchments. During the night Floyd and Pillow with 5,000 men escaped. Grant demanded "unconditional and immediate surrender," which Buckner was compelled to accept. The Confederacy lost an army of 15,000 men and a great quantity of artillery and stores. The way to Nashville was opened to the Union army, and Grant sprang at once into immediate popularity in the North.

FORTE, literally, in Italian, strong, and hence a term in musical EXPRESSION indicating loudness. It is commonly contracted to its initial letter. Its superlative is *fortissimo*, contracted to FF, or *fortississimo*, FFF.

FORT ERIE, BATTLE OF, Aug. 15, 1814, an engagement of the WAR OF 1812, which resulted in an American victory. After the BATTLE OF LUNDY'S LANE, the American army strengthened Ft. Erie, at the eastern extremity of the lake. The British, under Gen. Drummond, erected breastworks about two miles from Ft. Erie. Gen. Gaines took command of the American force, superseding Ripley. From Aug. 7-13 a long-range artillery duel was maintained. Shortly after midnight on the 14th the British troops assaulted the American works, but the movement was anticipated and resisted. The British seized and occupied a bastion, which exploded at the culmination of the furious battle; the British broke and fled back to their entrenchments. Their loss, including prisoners, was about 600; the American loss was 74.

FORT FISHER, BATTLE OF, Jan. 15, 1865, an engagement of the CIVIL WAR which resulted in a Federal victory. Wilmington, N.C., protected by Ft. Fisher, was the only southern seaport, after the loss of Savannah (*see* SAVANNAH, BATTLE OF), remaining in control of the Confederacy. On Dec. 20, 1864 the Federal fleet under Admiral Porter began operations against the fort. On the 25th, protected by a bombardment from the fleet, troops under Generals Butler and Weitzel were landed, and marched to the parapet of Ft. Fisher. But the Federal generals de-

cided that assault was useless, and the land force re-embarked for the return to Ft. Monroe. Grant ordered Admiral Porter to hold his position, and sent a second expedition, 8,000 troops under Gen. Terry. Terry's force, with the fleet artillery cooperating, carried the fort on Jan. 15, thereby closing the last gateway of the South to the outside world. Of the Confederate garrison of 2,200, 117 were killed and the remainder taken prisoners. Federal casualties were 266 killed and 1018 wounded.

FORTH, a river and firth on the east coast of Scotland, formed by the confluence of the Avondu and Duchray rivers near Aberfoyle. The river winds southeast in a tortuous course 66 mi. long, draining about 645 sq. mi. The Forth begins at Kincardine and extends 48 mi. out to the North Sea. In 1890 the famous Forth Cantilever Bridge, about a mile and a half long, was opened as a railway viaduct. There is a naval base at Rosyth. Several large islands lie in the firth, and there is a lighthouse on the Isle of May.

FORTH AND CLYDE CANAL, in Scotland, linking the Forth River at Grangemouth with the Clyde River at Bowling and including a branch to Glasgow, covering a distance of almost 39 mi. The canal at its highest point is 156 ft. above sea-level, has an average surface width of 56 ft., an average bottom width of 27 ft. and permits the passage of vessels of 8½ ft. draft. There are 20 locks on the eastern portion and 19 on the western. Each lock is 74 ft. long and 20 ft. wide, and procures a rise of 8 ft. This waterway is crossed by 33 drawbridges and passes over 10 large aqueducts and 30 small tunnels. The canal was completed in 1790, incorporated with the Monkland Canal in 1846 and in 1867 both canals passed into the control of the Caledonian Railway Company. In 1801 Symington tried his first steamer on this waterway. Proposals are being made to enlarge it to accommodate large sea-going vessels.

FORT HENRY, BATTLE OF, Feb. 6, 1862, Gen. Grant's opening victory in his campaign against the Confederate army in the West. Receiving permission from Gen. Halleck, his senior officer, to proceed against the Confederate strongholds on the tributaries of the Ohio, Grant, with the assistance of Flag-Officer Andrew H. Foote, who commanded the Union fleet on the Mississippi, embarked 15,000 men on transports. Seven gunboats convoyed the expedition. Sailing up the Tennessee to Ft. Henry, Grant disembarked his infantry four miles below the fort. Before the land force arrived the Union fleet began the attack, and after an engagement of an hour and a half Gen. Tilghman and the Confederate force surrendered. The navigation of the Tennessee River thereby passed into Unionist control.

FORT LAUDERDALE, a port city on the southeastern coast of Florida, the county seat of Broward Co., on the New River and the East Coast Canal, 25 mi. north of Miami. There is a municipal airport. Bus lines, steamship connections and two

railroads serve the city, which is a popular winter resort. There is some manufacturing. Truck crops are raised in the vicinity. The Seminole Indians inhabit the Everglades not far distant. Fort Lauderdale was founded in 1896 and incorporated in 1911. Pop. 1920, 2,065; 1930, 8,666.

FORT LEE, a rapidly growing borough of Bergen Co., N.J., situated on the Hudson River palisades overlooking New York City. It is the New Jersey terminus of the George Washington Memorial Bridge and is served by electric trolleys and numerous motor bus lines operated over the extensive system of highways connecting with the interstate bridge. While primarily a residential community it has a number of local industries including several establishments connected with the motion picture industry. A fort, originally called Fort Constitution and later renamed Fort Lee in honor of General Charles Lee, was the scene of several important encounters during the Revolution. Fort Lee was incorporated as a borough in 1904. Pop. 1920, 5,761; 1930, 8,759.

FORT MADISON, a city in southeastern Iowa, county seat of Lee Co., situated on the Mississippi River, 19 mi. southwest of Burlington. Bus and truck lines, river craft and two railroads serve the city. There also is an airport. Fort Madison is an important industrial center, manufacturing chiefly fountain pens, paper and various metal products. In 1929 the factory output was valued approximately at \$14,000,000; the retail trade amounted to \$6,433,622. The countryside produces principally corn; dairying is engaged in extensively. Commercial fisheries also afford industrial activities. Early in the 19th century a stockade was built for protection against the Indians, and later a settlement was founded. Pop. 1920, 12,066; 1930, 13,779.

FORT MARION NATIONAL MONUMENT, a tract of 18 acres at St. Augustine, Fla., set aside as a government reservation in 1924 and administered by the War Department. This picturesque old fort, originally called San Marco, was built by the Spaniards in 1656. It is surrounded by a moat and is a fairly well-preserved example of Spanish military architecture. Repeated assaults by both English and French were successfully withstood by this fortification. The Indian chief, Osceola, instigator of the second Seminole war, was temporarily confined here before being permanently imprisoned in Fort Moultrie.

FORT MATANZAS NATIONAL MONUMENT, a one acre tract on an island in Matanzas Bay, Fla., approximately 15 mi. south of St. Augustine. It was set aside in 1924 as a government reservation under the administration of the War Department to preserve the remains of an old fort, a relic of the Spanish invasion.

FORT McHENRY, BATTLE OF, Sept. 13-14, 1814, an engagement of the WAR OF 1812, which resulted in an American victory. After the razing of Washington the British moved against Baltimore, expecting to take plunder from its commerce and stores. In a skirmish near North Point Gen. Ross was killed;

Col. Brooke succeeded to the British command. The fleet under Admiral Cochrane cooperated with Brooke in the assault upon Ft. McHenry, where Gen. Armistead commanded the 3,500 men posted for the defense of Baltimore. After the cannonade had lasted several hours, Cochrane ordered three bomb vessels forward to increase their effectiveness. Armistead ordered a general cannonade which repulsed the vessels. The British cannonade continued until midnight, as a diversion to the approach of troops. But the guns of Ft. McHenry halted the British land forces. At seven next morning, after a 25 hours' bombardment costing only 28 casualties, the British withdrew.

FORT McHENRY NATIONAL MONUMENT, a tract of 47 acres near the city of Baltimore, Md., set aside as a government reservation in 1925 under the administration of the War Department to preserve the birthplace of the American national anthem. In 1814, FRANCIS SCOTT KEY was confined for a night on a British battleship during the British bombardment of this fort which was defending Baltimore. In the morning his relief and joy at seeing the American flag still flying inspired him to compose *The Star-Spangled Banner*.

FORT MEIGS, BATTLE OF, May 1-5, 1813, an engagement of the WAR OF 1812. Ft. Meigs, on the Maumee River, was built in Feb. 1813 by Gen. Harrison, commanding the American army in the West, and garrisoned by about 1,200 men. A British force of 700 regulars, under Gen. Proctor, and 1,500 Indians, under Tecumseh, attacked the fort in a series of sorties, May 1-5. In the course of these skirmishes 800 militiamen from Kentucky under Col. Dudley were routed with a loss of 630. The arrival of 1,100 troops under Gen. Clay gave the Americans the numerical advantage. Proctor abandoned the siege, hastened in his decision by desertions of Indians who were becoming restless at the prolonged conflict.

FORT MOULTRIE, BATTLE OF, June 28, 1776, an engagement of the REVOLUTIONARY WAR which resulted in an American victory. In Jan. 1776 Gen. Clinton with 2,000 British troops embarked from Boston to take possession of the southern colonies. Off the southern coast he was joined by Sir Peter Parker with 10 ships and 2,000 men from England, and decided to capture Charleston. Edward Rutledge, chief of the provisional government of South Carolina, assembled 6,000 militia to defend the city. Col. William Moultrie with 200 men was stationed in a rude fortress of sand and palmetto logs on Sullivan's Island, commanding the Charleston harbor. The British fleet attacked Ft. Moultrie with a bombardment lasting throughout the day but doing little damage, while the American fire, accurately sweeping the British decks, killed 225. Moultrie's loss was 32. The British fleet returned to New York, leaving the southern colonies unmolested for nearly three years.

FORT MYERS, a city in southwestern Florida, the county seat of Lee Co., on the Caloosahatchee

River, 145 mi. northwest of Miami and directly west of Palm Beach. Bus lines, steamships and two railroads serve the city. There is a municipal airport. The region is a fine farm and fruit growing country. Fort Myers is a popular winter resort, known as the "City of Palms," noted for its tarpon fishing. Ancient Indian mounds are found in the vicinity, and near by are the Everglades, inhabited by the Seminole Indians. Fort Myers was the winter home of Thomas A. Edison for nearly half a century. The city was founded in 1841; incorporated in 1905. Pop. 1920, 3,678; 1930, 9,082.

FORT NIAGARA, OLD, a fort in northwestern New York State at the confluence of the Niagara River and Lake Ontario. The first fort erected on this site was built in 1679 under the direction of the French explorer LA SALLE and was known as Fort Conti. This fort burned a year later and in the summer of 1687 Fort De Nonville was erected. The Castle or present Old Fort Niagara was built by the French in 1727. This fortification was purposely given a peaceful aspect to reassure the Indians and thus to insure the continuance of the fur trade which made the site of this fort an invaluable strategic position throughout its early history. During the FRENCH AND INDIAN WAR in 1759 the French were forced to surrender the fort to the English. At the close of the Revolution it was ceded to the United States but was actually held over until 1796. It again changed hands during the War of 1812, falling easy prey to the British, but was restored to the United States by the TREATY OF GHENT. The fort was in danger of disintegrating and falling into Lake Ontario until Congress appropriated funds in 1924 to repair the sea wall. The fort is now being restored, as it was in 1727, according to the original plans which were found in the Archives of the Colonies in Paris where they had lain for over 200 years.

FORT PIERCE, a town in southeastern Florida, the county seat of St. Lucie Co. It is situated on the Atlantic Ocean, at the mouth of the Indian River, about 60 mi. north of Palm Beach, and is served by the Florida East Coast Railroad. Fort Pierce has lumber mills, barrel factories, boat building and commercial fisheries. It is a shipping point for citrus fruit and truck crops. The population is growing rapidly. Pop. 1920, 2,115; 1930, 4,803.

FORT PULASKI NATIONAL MONUMENT, a tract of 20 acres on an island at the mouth of the Savannah River in Georgia. It was set aside as a government reservation in 1924 under the administration of the War Department. Fort Pulaski was built in 1810 to replace Fort Greene of the Revolutionary War.

FORTRESS MONROE, a fort guarding the entrance to Hampton Roads, situated at Old Point Comfort, Va. It is one of the largest military posts in the United States, and occupies an area of over 275 acres. JEFFERSON DAVIS, once President of the Confederacy, was imprisoned here at the conclusion of the Civil War.

FORT SCOTT, a city and the county seat of Bourbon Co., in southeastern Kansas on the Marmaton River, 96 mi. south of Kansas City. Three railroads and bus lines serve the city. The natural resources of the vicinity are coal, oil, gas, lead and zinc. Grain, alfalfa and soy beans are raised in the district. The local industries include the manufacture of overalls, condensed milk, brick and cement. In 1929 the factory output reached about \$2,000,000; the retail trade amounted to \$6,667,653. In 1842 a fort was built here, the officers' quarters of which are still standing. Pop. 1920, 10,693; 1930, 10,763.

FORT SMITH, a city and the county seat of Sebastian Co. in western Arkansas, situated on the Arkansas River 168 mi. northwest of Little Rock. Bus and truck lines, air transportation and six railroads serve the city. There are extensive gas and coal fields nearby. Cotton, fruit and vegetables are the crops of the vicinity. Fort Smith is a large industrial center, manufacturing scissors, furniture, glass, automobile bodies and other products. In 1929 the factory output reached the approximate sum of \$15,000,000; the retail trade amounted to \$16,621,474. The city was founded in 1817. The city is historically connected with the names of Gen. Sam Houston and his Indian bride, Talihina, Gen. Zachary Taylor, Jefferson Davis, Sequoyah, the "American Cadmus," I. C. Parker, the "hanging judge," and others. Pop. 1920, 28,870; 1930, 31,429.

FORT STANWIX, SIEGE OF, Aug. 3-22, 1777, an expedition of the REVOLUTIONARY WAR conducted by Col. St. Leger with 1,700 British regulars, Tories and Indians against an American garrison of 750 men under Col. Peter Gansevoort. Ft. Stanwix, on the site of the present Rome, N.Y., blocked St. Leger's projected expedition through the Mohawk valley to effect a junction with the main British force under Burgoyne. BENEDICT ARNOLD with 1,200 Continental troops was dispatched to the relief of the garrison. When within 20 miles of the fort Arnold sent ahead a half-witted Tory who rushed into St. Leger's camp with the spurious report that Burgoyne was defeated and that an overwhelming American force was approaching. The Indians became panic-stricken, the morale of the Tories was destroyed, and before Arnold arrived at Ft. Stanwix the British army had dispersed.

FORT SUMTER, BATTLE OF, Apr. 12, 1861, the opening conflict of the CIVIL WAR. Ft. Sumter, overlooking the Charleston, S.C., harbor, was garrisoned by 80 Federal troops under Maj. Robert Anderson. Acting upon orders from the Confederate Cabinet, Gen. Beauregard, commanding the provisional army of the Confederacy, on Apr. 11 demanded its evacuation. The demand was rejected and at 4:30 A.M., Apr. 12, was fired the first shot of the war, a signal shell from Ft. Johnston, opposite Ft. Sumter, giving notice to the Confederate batteries to begin the cannonade. The bombardment, lasting 34 hours, reduced Ft. Sumter to ruins. Anderson accepted terms of honorable surrender, and marched out on

the afternoon of the 14th. There were no fatalities on either side; but the outbreak of hostilities, after months of uncertainty and apathy, aroused the patriotic sentiment of both North and South. The response in the North was the mobilization of militiamen; in the South, the accession of all the slave states, except Delaware, Maryland, Kentucky and Missouri, to the Confederacy.

FORT THOMAS, a city of Campbell Co., Ky., situated on a bluff overlooking the Ohio River, 4 mi. from Cincinnati, O. It is a residential community which has developed in the vicinity of a United States military post, established in 1887. During 1929, 60 retail stores in Fort Thomas reported total annual sales of \$1,100,342. Pop. 1920, 5,028; 1930, 10,008.

FORTUNE BAY OUTRAGE. On Sunday, Jan. 6, 1878, American fishing boats drawing seines along the inshore waters of Fortune Bay, on the south coast of Newfoundland, were attacked by a number of Newfoundland fishermen and considerable damage done. To the demand for reparations made by the United States, the British Government replied that the provincial law of Newfoundland forbade fishing on Sunday, and that shore fishing, as permitted the United States in the Treaty of Washington (*see* HALIFAX FISHERIES COMMISSION) did not permit landing to draw seines. The Department of State contended that no provincial law could interpret or impair a treaty. Eventually Great Britain acknowledged the justice of the claim, and in 1880 paid \$15,000, about an eighth of the reparations demanded, to the United States. The award was distributed among the victims of the outrage.

FORTUNE-TELLING, the age-old quest to predict fate by special systems. It extends in a wide sweep from ancient magical arts to modernized pseudo-systems reared on the vestiges of ancient lore and folk superstitions. DIVINATION comprises one large class of reading of signs, omens and portents; fortune-telling has developed along with the determination of character. ASTROLOGY determined the traits and predicted the fortunes of men according to the position of the stars and planets at the moment of birth and undertook to advise as to the issue of enterprises by indicating favorable and unfavorable times. PALMISTRY, in part related to it, read the lines of the hand; when PHRENOLOGY came along, it made similar readings and predictions.

Fortune-telling devices, such as by cards (*see* CARTOMANCY) and by reading leaves in teacups, arose under different cultures and have been especially connected with the claims of unusual powers to penetrate the future on the part of gifted persons, such as the seventh son of a seventh son. Fortune-telling maintains itself among the less intelligent classes, and has been a profession of the wandering gypsies for many generations. In older days it was associated with the black arts as well as with the gift of prophecy. J. J.

FORTUNE THEATRE, an Elizabethan playhouse built on the Bankside, Southwark, London, by

Philip Henslowe and the actor, Edward Alleyn, in 1600, and closed in 1649.

FORT WASHINGTON, BATTLE OF, Nov. 16, 1776, an engagement of the REVOLUTIONARY WAR, which resulted in one of the severest losses suffered by the American army. Ft. Washington, on the east side of the Hudson near the Harlem River, and Ft. Lee opposite, were insufficiently cannoned to prevent the passage of British ships in the Hudson. Gen. Washington determined to evacuate these posts and fortify West Point, farther up the river. Col. Magaw, commanding the garrison of 3,000 of Washington's best-drilled troops, was ordered to evacuate Ft. Washington if the British approached, but received conflicting orders from the Continental Congress directing him to defend the position. He chose to remain, and was attacked by Gen. Howe with 5,000 troops. The British, despite casualties of 700 men, carried the works and captured the entire garrison with a large quantity of artillery and ammunition.

FORT WAYNE, a city and county seat of Allen Co., northeastern Indiana, located at the junction of the St. Joseph and St. Mary rivers, 148 mi. southeast of Chicago, Ill. An important railroad center, it is served by the New York Central, Wabash, Pennsylvania and other railroads, bus and truck lines, and airplanes. Fort Wayne has an area of about 15 sq. mi. and is well laid out with spacious parks and boulevards. Located here are Concordia College, the State School for Feeble-Minded Youth, a fine library, well-equipped hospitals, and music and art schools. Fort Wayne is in a rich agricultural district where farming is extensively carried on. The city manufactures over 235 different commodities, of which the leading are pumps and pumping equipment, foundry and machine shop products, trucks, electrical goods and printed matter. The factory output in 1929 was valued at \$121,557,771. The wholesale trade in 1929 amounted to \$35,919,164; the retail trade to \$74,051,752. Fort Wayne occupies the site of a Miami Indian village. The outpost which grew up was destroyed in 1790, but Gen. ANTHONY WAYNE erected a fort here four years later. From this developed a village which became an important shipping point with the completion of the Wabash and Erie canal. Railroad building in the middle of the last century greatly increased its importance. Fort Wayne was chartered as a city in 1840. Pop. 1920, 86,549; 1930, 114,946.

FORT WILLIAM, leading city of Thunder Bay District, Ontario, Canada, situated on the Kaministiquia River which empties in three branches into Lake Superior, a mile distant, 175 mi. northeast of Duluth, Minn., and 850 mi. northwest of Toronto. A "Twin City" with Port Arthur, 4 mi. to northeast, Fort William is a lake port and terminus of the Canadian Pacific Railway and of several steamship lines. Exports include the lake fisheries catch, the regional mineral deposits, and farm and grain produce. The Canadian sample grain trade makes its headquarters in the city. Hydroelectric power is available for pulp, paper and flour mills and foundries. A substantial

industrial center, Fort William was established by Duluth in the late 17th century as a trading post. Pop. 1921, 20,541; 1931, 26,277.

FORT WOOD NATIONAL MONUMENT, a tract of 2.5 acres on Bedloe's Island in New York Harbor. It is the site of the Statue of Liberty, presented to the United States in 1886 by the people of France.

FORT WORTH, a city in northern Texas, the county seat of Tarrant Co. It is situated on Trinity River at the point where the West Fork and Cedar Fork meet, 30 mi. west of Dallas. Bus and truck lines, airplanes and numerous railroads serve the city. Fort Worth is an important transportation point and a financial and industrial center. Lying in the geographical center of the largest oil fields of the country, great quantities of petroleum are piped into its refineries. Grain, meat and livestock are shipped. The city is the headquarters of the Texas Southwestern Cattle Raisers Association and the Southwestern Exposition and Fat Stock Show. Fort Worth has been called the largest livestock market and packing center of the south. In 1929 the factory output was worth about \$113,000,000; the retail trade amounted to \$108,763,944; the wholesale trade proper, to \$219,312,136. The city is an educational center of Texas, being the seat of Texas Christian University, Texas Woman's College, Southwestern Baptist Theological Seminary and Victory College. Fort Worth was founded in 1849 as a military post by Maj. Ripley Arnold, and was known as Camp Worth. It was incorporated as a city in 1873. Pop. 1920, 106,482; 1930, 163,447.

FORUM, an open space in Roman cities set apart for public business. The word has taken on the derivative meaning of an assembly for discussion, and even of a court. The early Forum, in Rome, was both market and meeting place, and was also used for games. Soon, however, in the capital and other large cities, the trade uses of the public square attained such proportions that fora in two classes were provided: the *fora civilia* for public business, political assembly and bankers' meetings, and the *fora venalia* for commerce. The latter class was subdivided also; and these fora were the classical equivalents, as they were the forerunners, of the town market squares.

The *forum civile* remained "the forum," and about it the chief public buildings were grouped. In Rome itself, several emperors built fora, and at one time there were 17 in the imperial city. The largest and most magnificent was the Forum of Trajan, but the *Forum Romanum*, or *Forum Magnum*, which we know to-day as the Forum of Rome, was the oldest and historically the most important. As it was built and added to over a long period of time, it was less symmetrical in plan than most fora. It contained five temples, the *Rostrum* for speakers, the *Curia* or Senate-house, the *Comitium* for common assembly, the Basilica Julia, the Basilica Aemilia, and other structures. The *Rostrum* was richly ornamented with sculpture and commemorative columns, and in the open space itself were many statues of famous men.

Among the imperial fora, no two were exactly alike, but the arrangement of the Forum of Trajan shows the general plan. Entered from the Forum of Augustus by a triumphal arch, the open space of the forum proper was about 280 feet wide. On the side opposite the entrance stood the great Basilica Ulpia, the largest in Rome, and along the other two sides extended covered porticoes, adorned with double rows of columns, beyond each of which was a semicircle of two-storied shops and offices. Beyond the basilica was a smaller columned square, containing Trajan's column, libraries and the temple of Trajan.

The Forum of Pompeii presents an interesting example of the smaller, but carefully arranged forum of the provincial town.

FORZA DEL DESTINO, LA, (The Force of Destiny), an opera in four acts by GIUSEPPE VERDI, libretto by Francesco Piave, after the play *Don Alvaro o la Fuerza del Sino* by the Duke of Rivas; première, Petrograd, Nov. 10, 1862; first performed in the United States, Feb. 24, 1865, at New York.

The story is laid in Spain and Italy during the middle 18th century. Alvaro accidentally shoots the Marquis of Calatrava, father of Leonora, with whom he is eloping. Carlos, son of the slain marquis, sets out to find Alvaro, who is living in Italy as Federigo. Unaware of his real identity, Carlos meets the slayer of his father and becomes his closest friend. Carlos then learns that Alvaro and Federigo are one, and challenges him to a duel. The marquis's son is mortally wounded but has strength remaining to stab his sister when she kneels to embrace him. The story concludes with the suicide of the luckless Alvaro.

FOSCOLO, UGO (1778-1827), Italian poet, patriot and critic, was born on the Island of Zante, Jan. 26, 1778, of Venetian stock. He passed his poverty-stricken youth in Venice. A patriot, he was consumed by a passion for Italian liberty. As a poet, his fame rests on two works. The *Ultime Lettere di Jacopo Ortis*, 1798, is a psychological romance. The *Sepolchri*, 1807, is a lyric poem invoking the great dead to fire the Italian conscience. Foscolo died in exile at London, Oct. 10, 1827, in abject poverty. His remains were removed to Florence in 1871 as a national tribute to his genius and patriotism.

FOSDICK, HARRY EMERSON (1878-), American clergyman, was born at Buffalo, N.Y., May 24, 1878. After graduation from Colgate University in 1900, and from Union Theological Seminary in 1904, he became pastor at Montclair, N.J. Four years later he filled the chair of homiletics at Union Theological Seminary, meanwhile having become favorably known as a university preacher. From 1918 to 1925, he was special preacher of the First Presbyterian Church in New York City but resigned when required to take the vows of a Presbyterian minister. In 1925 the Park Avenue Baptist Church of New York called him as pastor of its large newly erected Riverside Church.

FOSDICK, RAYMOND BLAINE (1883-), American lawyer and sociologist, was born in Buffalo,

N.Y., June 9, 1883. He graduated at Princeton in 1905, was admitted to the bar three years later, and was assistant corporation counsel in New York, 1908-10. He became commissioner of accounts there in 1910, and in 1913 the Rockefeller Bureau of Social Hygiene appointed him to study police organizations in Europe. During the World War, he held various posts in the War and Navy departments. He served as Under-Secretary General of the League of Nations, 1919-20, and has since been prominent among those urging United States entrance into the League. He is a trustee of the Rockefeller Foundation and of Princeton University, and a member of numerous learned societies. Among his writings are: *European Police Systems, Keeping Our Fighters Fit*, and *The Old Savage in the New Civilization*.

FOSSIL, in sedimentary rocks the remains of natural impression, or merely traces of some plant or animal which lived prior to the present time. A fossil may be in rare instances the actual body itself, preserved in frozen ground, in amber, or in an asphalt pool, or it may be a PETRIFICATION, or merely a mold left in once soft mud, or a track made by the animal as it crossed a mud flat or sand beach. Usually fossils are only the hard parts of once living forms, such as shells, skeletons or woody tissues. See also PALEONTOLOGY; GEOLOGY; EVOLUTION.

FOSSIL CYCAD NATIONAL MONUMENT, a region in the Black Hills Rim in South Dakota. The 320 acres containing one of the most interesting fossil-plant beds yet discovered anywhere in the world, were set aside as a national monument by presidential proclamation, Oct. 21, 1922. The cycads were fern-like trees which flourished millions of years ago in the age of egg-laying monsters. These trees are particularly remarkable in that they bore large and beautiful flowers in great profusion. Although none of the full-grown flowers have been preserved, undoubtedly because they were too delicate to survive the initial processes of fossilization, the deposit contains trees with as many as 500 buds.

Specimen fossils may be seen at the National Museum in Washington. The monument is accessible from the Denver-Deadwood Highway which touches its southwestern border, from Hot Springs, S.D., on the Chicago and Northwestern railroad, and from Edgement and Minnekahta, on the Chicago, Burlington and Quincy railroad.

FOSTER, STEPHEN COLLINS (1826-64), American song writer, was born at Pittsburgh, Pa., July 4, 1826. He was educated at Jefferson College, Cannonsburg, Pa., and studied music while working in Cincinnati. His earlier songs, *Open Thy Lattice, Love, Uncle Ned* and *O Susannah!* proved so successful that he adopted song writing as his career. He wrote both music and words, fitting his phrases to his melodies with remarkable felicity. Both his Negro and his sentimental pieces show sympathy and humor. Among some 125 songs besides those mentioned are *The Old Folks at Home*, perhaps the most popular song ever written in America, *Old Black Joe*, *Suwan-*

nee River, Nelly was a Lady, Old Dog Tray and the charming serenade, *Come Where My Love Lies Dreaming*. Foster died in New York City, Jan. 13, 1864.

FOSTORIA, a city of Seneca and Hancock counties, O., 35 mi. south of Toledo. The New York Central, the Baltimore and Ohio, the Nickel Plate, the Lake Erie and Western and the Hocking Valley railroads serve the city and there is a commercial airport 1 mi. east. Fostoria is a trading center for an agricultural and stock-raising country, and the Lima oil field occupies territory to the southwest. The city's manufactures include automobiles, radio batteries, washing-machines and foundry products of brass and iron. There are also serum plants. The retail trade in 1929 amounted to \$7,702,896. Chartered in 1854, Fostoria was formed by the consolidation of two towns, Rome and Risdon, which had occupied the site from 1832. Its name is derived from that of its founder and builder, Charles W. Foster, father of Charles Foster who was governor of Ohio, 1880-84, and Secretary of the United States Treasury, 1891-93. It is governed under a charter of 1889. Pop. 1920, 9,987; 1930, 12,790.

FOUCAULT, LÉON (1819-68), French physicist, was born at Paris, Sept. 18, 1819. In 1855, soon after his appointment as physicist of the Paris Observatory, he established that a pendulum persists in the established axis in which it is swinging regardless of the motion of the earth. Thus the axis appears to shift, so that at the poles the axis would seem to revolve every 24 hours to the right at the north, to the left at the south. Foucault established that the time of revolution varies with the sine of the latitude, by which relation there is no revolution at the equator ($\sin 0^\circ = 0$) to one revolution every 24 hours at the pole ($\sin 90^\circ = 1$). Foucault developed the reflecting telescope with which he conducted tests of the speed of light, and invented the **GYROSCOPE**. He died at Paris, Feb. 11, 1868.

FOUCAULT PENDULUM refers to the experiment made by Foucault in Paris, in 1851, when he suspended a heavy iron ball from the ceiling of the Pantheon in Paris by a wire 200 feet long and used it as a pendulum. The apparent rotation of the plane in which the pendulum executed its swing constituted one of the best experimental proofs of the rotation of the earth.

FOUCHE, JOSEPH, DUKE OF OTRANTO (1759-1820), French statesman and public official, was born near Nantes, May 21, 1759. One of the most radical of the Jacobins, he voted for the execution of Louis XVI; led the Terror in La Vendée and central France and, lacking loyalty even to his own party, instigated the fall of Robespierre in 1794. He was made minister of police in 1799 but Napoleon, who had retained him under the Consulate, ousted him in 1802 because of his political intrigues. However, in spite of his distrust of Fouché, Napoleon found him useful and in 1804 restored him as head of the police under the Empire, and soon afterwards named him

Minister of the Interior, and Duke of Otranto. He then served the Empire in various capacities in Italy; but, always ready to ally himself with the winning side, he secretly encouraged the return of the Bourbons in 1815. On Napoleon's return from Elba, however, he was again named minister of police during the **HUNDRED DAYS**, and kept on by Louis XVIII. In 1816, finding himself definitely out of favor with the Bourbons he retired to Prague. He died at Trieste, Italy, Dec. 25, 1820.

FOUNDATIONS, as applied to buildings, bridges, etc., are considered to be that portion of the structure which rests on the rock or soil. Foundation work generally includes the excavation to, and preparation of, the rock or sub-soil and the placing of the concrete, brick or other footings thereon.

Foundations must be constructed so as not only to take into consideration the safe carrying capacity of the bearing material, but also the type of building to be supported. The foundations of a factory or warehouse may settle slightly and perhaps unevenly without causing serious injury, whereas an office or hotel building, if subjected to an equal settlement, might have its plastered walls and ceilings seriously damaged.

There are a great variety in types of building foundations, such as: Those resting on soil or rock immediately below the lowest floor; Those carried down in the form of **CAISSONS** many feet below the lowest floors; And those supported by wood, concrete or steel piles, etc.

There are two types of footings used to transfer the loads from the bases of the building columns to the supporting medium, whether of soil, rock or piles. One type consists of crossed layers of structural steel beams placed in the form of steel "grillages" thoroughly encased and protected by concrete. The other type consists of spread footings of brick, or concrete reinforced with steel rods. G. A. H.

FOUNDATIONS, agencies of public welfare, supported by sums of money constituting a permanent fund. Such endowments are generally made by individuals of large means, and the income of the foundations so established is applied to effecting improvements in the fields of religion, education, public health and the like. Save in a few instances the resources of foundations are not employed for general charitable relief, but are used to promote specific ends in the aforementioned fields. Otherwise described, foundations are the machinery created to disburse the funds and direct the work of modern philanthropy (*see* **PHILANTHROPY**). These institutions were an outgrowth of the industrial system of the 19th century, in which modern civilization was first confronted with the hardships of factory workers. Endowments to improve the housing conditions of the workers were first made in England during the time of Robert Owen (1771-1858), celebrated for his efforts on behalf of factory reform. The amelioration of housing conditions by the income of private trusts led philanthropists next to turn to education. One

of the first educational foundations in England was that provided by Cecil Rhodes (1853-1902), who established 200 scholarships at Oxford University. Similarly, on the Continent in the 19th century, notably in Germany and France, foundations were established to raise the living standards of the industrial classes and to extend university training to talented young men without means for higher education.

In the 20th century the United States led all nations in the combined resources and variety of aims of its foundations. This was due chiefly to the wealth of the country, its intense industrialization, which presented sanitary problems of vital importance to all urban communities, and to the advance of popular education. But the forerunner of the present-day foundation in the United States belongs to the preceding century, in which George Peabody gave between \$8,000,000 and \$9,000,000 to the Peabody Educational Fund, for educational purposes in the Southern States and to American universities. In Jan. 1930 the Russell Sage Foundation, created in 1907 by Mrs. Russell Sage as a memorial to her husband, reported that there were 151 American foundations for social welfare, supporting work in, or contributing directly to, architecture, blind relief, child welfare, city planning, delinquency and penology, economic research, education (scholarships, student loans and the like), eugenics, family welfare, forestry, health, housing, industrial research, international amity, landscape architecture, libraries and library establishment, motion pictures, municipal improvement, music, negro welfare, pensions, political education, population problems, recreation, individual relief, research, statistics and surveys and exhibits. The total of 151 foundations does not include the community trusts established in scores of cities for charitable and educational relief. The total sums spent by these foundations are not available, but the growth of their donations may be partly gauged by the enormous sums spent in the United States in philanthropic work of all descriptions. In 1921 philanthropic donations were estimated at \$1,719,000,000, in 1925 \$2,068,570,000, and in 1929 \$2,450,720,000. The large foundations in the United States include the Carnegie Trusts, the Rockefeller Foundation, Julius Rosenwald Fund, Russell Sage Foundation, Commonwealth Fund and the John Simon Guggenheim Memorial Foundation.

FOUNDRY. See CASTING.

FOUNTAINS ABBEY, the finest and most complete of the ruined English abbeys, beautifully situated on the grounds of Lord Ripon's estate, Studley Royal, near the River Skell, 3 mi. from Ripon, Yorkshire. The abbey was founded by Cistercian monks from St. Mary's Abbey at York in 1132, but the buildings were not properly completed till about 200 years later. The Transitional church, 380 ft. long, which is roofless but otherwise well-preserved, and which has a fine tower 170 ft. high, is the most notable single remnant. Of the former domestic buildings of the abbey, the most interesting are the chapter house, the dormitory, the cloisters, the cale-

factorium or warming house, and the 13th century refectory. Fountains Abbey was dissolved by Henry VIII during the Reformation.

FOUQUÉ, FRIEDRICH HEINRICH DE LA MOTTE, BARON (1777-1843), German writer, was born at Brandenburg, Feb. 12, 1777. His *UNDINE*, 1811, remains a classic fairy tale charged with the ideal of chivalry. His writings include romances, poetic dramas and poems. Among his prose tales are *Der Zauberring* and *Aslauga's Ritter*. Fouqué was the first German to dramatize the *Nibelungen* saga, and he wrote a well-known historic epic, *Bertrand du Guesclin*. He was an ardent romantic and opposed modernistic trends in literature. Several volumes of poems and an autobiography, *Lebensgeschichte des Baron Friedrich de la Motte Fouqué*, are among his publications. He died at Berlin, Jan. 23, 1843.

FOUR-COLOR PROCESS, the blending of four colors by printing one above the other successively, to obtain a desired shade. Modern process COLOR PRINTING is based upon two discoveries or inventions: the discovery that from the pure pigments of yellow, red and blue any color or shade may be produced by blending; and the invention of the halftone printing plate, which permits the application of any amount of color by means of printing. In actual practice the production of colors by blending pigments is not fully in keeping with the theory. The two-color combinations work out very well, and can be delicately toned and shaded by the third color; but the use of all three does not produce a satisfactory black; because of the impurity of pigments, the resultant color is a deep brown. Where this is objectionable, the printer does not attempt a process black, but adds a pure black pigment as a fourth color. This, moreover, permits sharper detail, and simplifies other combinations that are difficult with only three colors. The disadvantage of the three-color process makes necessary the four-color process in general use.

The artist produces his colors by mixing pigments on his palette, and transfers the desired shade to his canvas. The printer mixes his colors by printing them on the paper, having determined in advance exactly how much of each color will be needed for each part of the design. In the blending of colors, pigments do not merge with each other. The finely ground particles lie so close together that the eye does not distinguish two colors, but sees the resultant color. For example, if yellow and blue pigments lie so close together that the eye cannot see them separately, the color sensation is green. The half-tone plate, capable of extreme graduations of tone, is the means used to place the colored inks upon the paper, a separate plate being prepared for each color. This is produced by the photo-engraver, by placing color filters before the camera. These filters extract all light rays except those wanted for each plate. For example, in preparing the red printing plate, all color values of the copy except the red are filtered out. The plate thus produced is capable of printing only the red values of the copy. The other plates are similarly made, and, when ex-

perly done, the resultant print is surprisingly faithful to the original in color values. E. W. P.

4 H CLUBS, organizations forming part of the national agricultural extension system. In them boys and girls of 10 to 20 years of age who live in rural districts are taught better agricultural and homemaking practices and how to develop personally and socially. The clubs started in 1910 through the leadership of Theodore Roosevelt's Country Life Commission, although there had been garden and homemaking organizations of various kinds for a generation before. Begun in Wright County, Iowa, with corn clubs, baby beef clubs, home canning clubs, sewing, millinery and other groups stimulated by the county superintendent of schools, the 4 H club movement has since adopted the four leaf clover emblem, established Annual Achievement Day programs and awards. The movement was taken over by the U.S. Dept. of Agriculture, which from 1910 to 1923 organized it first in 12 southern states. In 1931 out of 11,000,000 children of its age-range in rural districts, it included 770,000.

The purposes are expressed in the four H's which the members pledge: the head to clearer thinking, the heart to greater loyalty, health to better living and hands to larger service to club, community and county. Achievements in contests are recognized in grades, profits, self-earned property and honor. Agencies that are foremost in the work are county agricultural agents, home demonstration agents, Y.M.C.A.'s, Y.W.C.A.'s and summer Bible schools. L.E.R. E. B.

FOURIER, FRANÇOIS CHARLES MARIE (1772-1837), French Socialist, was born at Besançon, Apr. 7, 1837. In 1808 he published anonymously his first contribution to Socialist theory and plan, a *Théorie des quatre mouvements*, which outlined his belief in the essential rightness and harmony of human conduct when not unnaturally restrained, and also outlined a project for the arbitrary reorganization of society. Later writings attracted attention to his theories and system of community living. Fourier's best known book was probably *Le Nouveau Monde industriel*, published in 1829-30. He disagreed violently with the Socialism of his contemporaries and rivals, Robert Owen and the Comte de Saint-Simon. Several communities on Fourier's plan were projected in the United States, the most important being that of BROOK FARM. Fourier died at Paris, Oct. 10, 1837.

FOURIERIST PHALANXES, communal settlements founded on the principles of, or at least under the inspiration of, the social theories of Francois Charles Marie Fourier (1772-1837) as first exemplified in the *Théorie des Quatres Mouvements*, 1808. Although only two phalanxes were founded in his native France, in the United States a minimum of 41 such settlements were established. Fourier's theories were introduced into the United States by Albert Brisbane, stressing the "idea of dignifying and rendering attractive the manual labor of mankind" in his volume *The Social Destiny of Man*, 1840, and in the column which he conducted in the *New York Tribune*, 1842-44. Horace Greeley, Parke Godwin, and several of

the Transcendentalists (see BROOK FARM) were among the many active converts. Phalanxes were founded independently, with little capital, with too few members and with overemphasis on agricultural labor. The compromise between cooperation and individualism inherent in Fourierism was a contributory factor to the brevity of existence of most phalanxes. The North American Phalanx, in Monmouth County, N.J., 1843-54, outlived all the others, and most nearly applied the full body of Fourier's social theory. The Wisconsin Phalanx (Ceresco) in Fond du Lac County, Wis., was most successful, the forced sale of properties in 1850, the sixth year of its existence, yielding 108% to the shareholders.

FOUR O'CLOCK (*Mirabilis Jalapa*), a showy perennial herb of the four o'clock family (*Nyctaginaceae*), called also marvel-of-Peru. It is a native of tropical America, frequently cultivated in gardens as an annual. The much-branched stems, rising from tuberous roots, grow from 1 to 2 ft. high, bearing oblong deep green leaves and fragrant red, yellow, white or striped flowers which blossom late in the afternoon.

FOUR-POWER PACIFIC TREATY, an agreement devised at the WASHINGTON CONFERENCE, and signed Dec. 13, 1921 by plenipotentiaries of the United States, Great Britain, Japan and France, for the mutual protection of island possessions and mandates in the Pacific. Its actual intent was to permit Great Britain to recede from its existent obligations in the Pacific. France was not a party to the negotiations, but was induced to sign the treaty to give it an appearance of greater international scope, and so predispose public opinion in England in its favor. The contracting parties were pledged, if there should develop a controversy between any of them arising out of a Pacific question and "likely to affect the harmonious accord now happily subsisting between them," to meet the other signatories in a joint conference for adjustment of the problem; and, if their rights in the Pacific were threatened by any other Power, to "communicate with each other fully and frankly in order to arrive at an understanding."

FOURTEEN POINTS, the items formulated by President WOODROW WILSON before a joint session of Congress on Jan. 8, 1918, concerning his idea of the requirements of a peaceful settlement of the disorders brought to a head by the World War. They are: (1) open covenants of peace openly arrived at; (2) freedom of the seas; (3) removal where practicable of all economic barriers; (4) guarantees of reductions of national armaments; (5) impartial adjustment of all colonial claims; (6) evacuation of Russian territory and such settlement of all Russian questions as will enable her to obtain unhampered opportunity for independent determination of her own development; (7) evacuation and restoration of Belgium; (8) evacuation of occupied French territory and restoration of Alsace-Lorraine; (9) readjustment of Italian frontiers; (10) opportunity for autonomous development of races of Austria-Hungary;

(11) evacuation and restoration of Roumania, Serbia and Montenegro, with access to the sea for Serbia; (12) Turkish portions of the Ottoman Empire to receive assurances of sovereignty, opportunity for autonomous development of other nationalities under Turkish rule, and permanent opening of the Dardanelles to all ships; (13) independent Polish state with access to the sea, and (14) general association of nations under specific covenants in order to afford mutual guarantees of political independence and territorial integrity to all states. The list embodied President Wilson's ideal of a new school of diplomacy, with secret agreements eliminated, and all settlements to be "open, above board, and explicit"; the possibility of peace on this basis appealed to the people of central Europe, and on Oct. 4 Germany asked that the American Government take steps toward peace on the basis of the Fourteen Points. In Nov. the French, British, and Italian governments had promised—subject to reservations as to the freedom of the seas and explicit admission of Germany's obligation for all damages to civilian life and property—that peace should be made on that basis, and the armistice of Nov. 11 was arranged.

FOURTH DIMENSION, a possible dimension in addition to the three with which we are familiar,—length, breadth and thickness. To form some conception of the meaning of the term, we may first imagine beings which have concepts of length alone, and then those which can conceive of only length and breadth. To a rod bacillus in a capillary branch from a vein there may seem to be only one dimension possible; if it could think, it would probably think that length is the only one conceivable. To a thin amoeba on a glass plate there may seem to be only two dimensions,—length and breadth; it could, if it thought, probably conceive of no other. To us, there seem to be only three dimensions,—length, breadth and thickness; but the mathematician, who writes x^0 , x^1 , x^2 , and x^3 , naturally inquires why x^4 should not lead him to believe in four dimensions, even though he cannot point to it any more than he can point to yesterday or next year. Indeed, he asks whether time is not itself a fourth dimension. In mathematics there are many occasions when a fourth or even a higher dimension seems entirely reasonable, and mathematicians make free use of the idea. Indeed, scientists at present agree that the fourth dimension is necessary to the explanation of many phenomena. See DIMENSIONS.

FOUSSA or **FOSSA** (*Cryptoprocta ferox*), the largest carnivorous mammal in Madagascar, somewhat resembling both the civets and the cats. It has retractile claws on all four feet, but its hind feet are plantigrade; its body is shaped like a weasel's and is twice the length of a house-cat's, about 5 ft. from the tip of the snout to the end of its tapering tail. Its head, ears and tail are all longer than a cat's. The short, close fur, too, is different from that of either the civets or the cats in never being spotted or striped, but always a uniform pale brown. It is a

lithe, active creature, nocturnal in habit, with a reputation for ferocity. It will attack and carry off such large animals as goats, though usually preying upon birds and lemurs.

FOUST, JULIUS ISAAC (1865-), American educator, was born at Graham, N.C., Nov. 23, 1865. He graduated in 1890 at the University of North Carolina and for 11 years was superintendent of schools at Wilson, and at Goldsboro, N.C. In 1902 he became professor of pedagogy at the North Carolina College for Women and in 1907, president.

FOWL, a name once used to designate all birds, but now generally restricted in application to the domestic cock and hen; the word when employed in the singular without qualification specifically meaning a full-grown chicken. However, the domestic duck and the domestic turkey are sometimes called fowl, and in the plural the term is employed to designate all poultry. The word appears frequently as part of the common names of various birds of the pheasant group, as jungle fowl, pea fowl and guinea fowl, and also of some unrelated birds, as the garefowl or great auk, which recently became extinct. The terms wild fowl and water fowl are applied to numerous non-domesticated birds, but especially to game birds that are hunted for food. See also POULTRY.

FOWLER'S SOLUTION. See ARSENIC TRIOXIDE.

FOX, CHARLES JAMES (1749-1806), founder of British Liberalism, was born in London on Jan. 24, 1749. As his Christian names indicate, he was of Stuart ancestry, his mother being Lady Caroline Lennox, whose direct ancestor, the Duke of Richmond, was son of CHARLES II and Louise de Kerouille, Duchess of Portsmouth. His father, the first Lord Holland, indulgently educated him in all the extravagances of the time. Fox was thus a dual personality. On the racecourse and at the card table, he gambled away fortunes. But at Eton he acquired a life-long devotion to the classics while, by means of travel in Europe, he learned modern languages and developed an international viewpoint.

When he was only 19, a seat in Parliament was bought for him, and at 21, he was Junior Lord of the Admiralty under the reactionary LORD FREDERICK NORTH. But it was intolerable to the King that this boon companion of the dissolute Prince of Wales, afterwards GEORGE IV, who sympathized with JOHN WILKES and with the American Colonies, should be a minister and in 1774, Fox was dismissed. It was only after Lord North's fall from power that, in 1782, Fox returned to office as Secretary of State. The next year he suddenly formed an ill-fated coalition with his opponent North against the YOUNGER PITT. Over the India Bill, Fox was dismissed again by the King, and Pitt's ascendancy excluded him from office for more than 20 years. The policy of Fox was erratic. He declared that France was England's hereditary enemy, yet, supporting the FRENCH REVOLUTION, he quarrelled with EDMUND BURKE. He opposed the French war with such vehemence that in 1798 the King struck his name off the Privy Coun-

cil. At Pitt's death eight years later, Fox became Foreign Secretary under WILLIAM W. G. GRENVILLE, but he failed to secure peace from Napoleon. He was able to achieve only one reform, the abolition of the slave trade, for on Sept. 13, 1806, "the greatest debater the world ever saw," as Burke described Fox, died at Chiswick. He was buried in Westminster Abbey.

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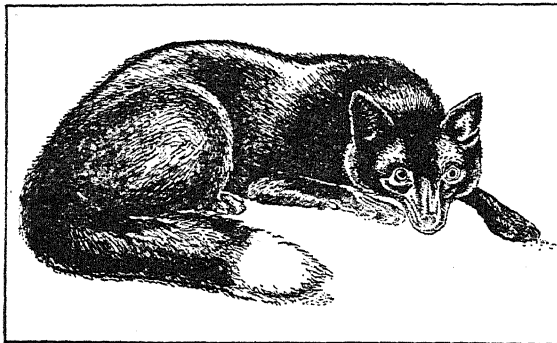
FOX, GEORGE (1624-91), Christian mystic and founder of the Society of Friends, commonly known as Quakers, was born at Fenny-Drayton, Leicestershire, England, in July 1624. In his youth he was apprenticed to a shoemaker. He early showed that he was subject to religious trances. At the age of 25 he became a wandering preacher, speaking against worldliness, insincere ecclesiastical Christianity, and upholding the authority of "the inner Light." The first Meeting House of Friends was opened in London, in 1650. From 1657 to 1669 he journeyed throughout England, Scotland and Ireland, and in 1671 crossed the Atlantic and preached in the West Indies and North America. He also made two journeys to Holland. The extensive establishment of his work is contemporary with his marriage in 1669, to a widow, Margaret Fell, a woman of superior intellect, who greatly assisted him. Fox was frequently imprisoned, and was harshly treated by the clergy, the magistrates and the mob. Of his literary remains, his *Journal* is the most important. The term *Quaker* was given to the society by Justice Bennett of Derby in 1650, who was admonished by Fox to tremble at the word of the Lord. In 1696 Parliament declared the Quaker "affirmation of truth" a legal oath. Fox died Jan. 13, 1691.

FOX, JOHN WILLIAM, JR. (1863-1919), American novelist, was born in Stony Point, Ky., Dec. 16, 1863. He was educated at Transylvania College and at Harvard. While engaged in mining ventures in the Cumberland Mountains he acquired a knowledge of the lives and feuds of the backwoods people. He published *A Cumberland Vendetta* in 1895 and *The Kentuckians* in 1897; later he wrote *The Little Shepherd of Kingdom Come* and *The Trail of the Lonesome Pine*. Fox died at Big Stone Gap, Va., July 8, 1919.

FOX, WILLIAM SHERWOOD (1878-), American educator, was born at Throopville, N. Y., June 17, 1878. He graduated at McMaster University, Toronto, in 1900 and until 1909 was instructor in Greek at Brandon College, Manitoba. From 1911-17 he was professor of Greek at Princeton. In the latter year he joined the faculty of the University of Western Ontario, where he became dean of the faculty of arts in 1919 and president in 1927.

FOX, a member of the dog family (*Canidae*) of which there are many species widely scattered over the world. The common North American red fox (*Vulpes fulva*) survives in large numbers, even near civilization. Its cunning has long figured in folklore.

Foxes live alone or in pairs, usually in burrows. From 4 to 8 cubs are born, usually in April. Foxes are carnivorous, living principally on rabbits, game birds, rats, mice, crawfish and even insects, but they also eat fruit and herbs. Foxes may be distinguished from dogs and wolves by their lighter build, longer and bushier tails, more pointed heads and relatively longer bodies and shorter legs. The fur is red, or, in the cross fox, red and gray, with lighter under parts. The cross fox, a color phase of the red fox, often has a brownish-black cross on the shoulder. Thousands of red fox pelts are marketed each year, the better ones being used in their natural color. Inferior skins are dyed black and pointed with white



BLACK OR SILVER FOX

to imitate the rare silver fox, which is another color phase of the red. Wild silver foxes are now extremely scarce, but several thousand pelts are taken annually from silver fox farms.

The valuable arctic or blue fox is a different species, which inhabits islands off the coast of Alaska. Another, the fur of which is highly prized, is the smaller white or arctic fox, a color phase of the blue fox. The Virginia, or gray fox (*Urocyon cinereoargenteus*), has iron-gray fur of less value.

FOXBOROUGH, a town and village in Norfolk Co., southeastern Massachusetts. The village is situated 22 mi. southwest of Boston, on the New Haven Railroad. The local manufactures are recording instruments, straw and felt hats. There are fruit, poultry and truck farms. Foxborough was founded in 1778. Pop. 1920, 4,136; 1930, 5,347.

FOXÉ, JOHN (1516-87), English martyrologist, was born at Boston, Lincolnshire, England, in 1516. Educated at Magdalen College, Oxford, of which he was made a Fellow in 1539, he became a Protestant and resigned his Fellowship in 1545. After five years as a private tutor, he was ordained a deacon, but was obliged to flee to the Continent to escape the persecutions under Queen Mary. Returning to England on the accession of Elizabeth, he became prebendary of Salisbury Cathedral. He is chiefly remembered for his *Acts and Monuments*, better known as *Foxe's Book of Martyrs* (1563). The book was well received by Protestants, but Catholics felt that he allowed party spirit to lead him into unintentional errors of statement. He died in London on April 18, 1587.

FOXGLOVE (*Digitalis purpurea*), a vigorous biennial of the figwort family highly valued for its powerful medicinal properties and widely grown in numerous handsome varieties as a garden ornamental. The plant, native to western Europe and common in the British Isles, has become sparingly naturalized through escape from gardens in many parts of North America. It grows from 2 to 5 ft. high, with a stout, erect stem bearing large leaves, sometimes 10 in. in length, and a long one-sided cluster of purple or whitish drooping flowers, 2 in. long, often spotted within. The leaves yield the poisonous drug digitalis, containing glucosides which are highly effective heart stimulants. *See also* DIGITALIS.

FOX-HUNTING, the chase of the fox with hounds and horses, was the successor to FALCONRY in England, and became a recognized sport of the aristocracy and upper classes during the Restoration. The sport was evolved from the much older recreation of stag hunting. Modern fox-hunting is an elaborate sport. The finest hounds, a strong and fleet breed of unknown origin, are bred in England. The cubs must first be "walked," the purpose of this "cub-hunting" being to train the young hounds to stick to the scent of the fox. The breeding of horses for the hunt is another special field.

The hunt, generally held between November and March, is supported by regional subscribers, who subsidize the packs of fox-hounds, and employ a master of fox-hounds, commonly known as the "M.F.H." The night before the hunt, gamekeepers are sent over the neighboring country for purposes of earth-stopping, or the closing of holes while the foxes are away foraging for food. The following day the members of the hunt gather on their mounts near the region where the "M.F.H." expects to work the hounds on to a drag. The pack is kept moving by the whippers-in. The entire hunt is in charge of the "M.F.H." and the huntsman, both dressed in scarlet coats, which are also worn by some hunters. When the pack raises a scent, the hounds bay, and after the bugle sounds, "Gone away!" the mounted riders follow the pack over the country. When a hunt member views the fox, he shouts, "View! halloo!" The riders nearest the quarry are obligated to attempt to save the brush, or tail; pads, or feet; and mask or head of the fox from the pack. These are presented as trophies to those riders "in at the death."

In the United States, fox-hunting dates from about 1740. In 1932 the number of packs numbered about 100, scattered over New England, the southeastern states, and the Middle West.

FOX RIVER, a river of Wisconsin, rising in that state near the southern boundary of Green Lake Co. It flows westward to Portage and here is connected by a canal with the Wisconsin River. At Portage the course of the Fox changes to northeast and runs through Marquette, Green Lake and Winnebago counties to enter Lake Winnebago at Oshkosh. It issues from the north end of the lake and continues northeast through Brown Co. into Green Bay. The Fox is navigable throughout and has considerable importance

as a trade stream since it is part of the waterway by which steamboats can pass from the Mississippi River to Lake Michigan. Its length is about 250 mi. In the lower part of its course there are rapids furnishing excellent water power.

FOXTAIL-GRASS, the name given to various grasses with bushy flowering spikes, especially to the meadow foxtails (*Alopecurus* sp.) and the bristly foxtails (*Setaria* sp.). The former are mostly pasture or meadow grasses with slender, soft, short-awned flowering spikes. The bristly foxtails, with large stiff-awned flowering spikes, are mostly agricultural weeds. The yellow foxtail (*S. lutescens*) and the green foxtail (*S. viridis*) are very common in cultivated soil in the eastern United States.

F. P. S. SYSTEM. *See* PHYSICAL UNITS.

FRACKVILLE, a borough of Schuylkill Co., in eastern Pennsylvania, situated 8 mi. north of Pottsville and served by two railroads. It is a shipping point for anthracite coal, the chief product of this region, and has factories turning out shirts, overalls and garments. Pop. 1920, 5,590; 1930, 8,034.

FRACTION, a word derived from the Latin word *frangere*, to break. Originally it meant a broken number, and was occasionally so called in the early English textbooks. If we break anything into four equal parts, each part is a unit fraction, $\frac{1}{4}$. In early times practically all fractions were of this kind. To avoid the difficulties of fractions the early astronomers divided the degree into sixtieths, our minutes, and these into sixtieths, our seconds, and so on into other sixtieths as far as needed. Thus they had, using our modern symbols which appeared in the 16th century, numbers like $5^{\circ} 2' 3'' 15''' 25^{IV}$.

Because these represented 60ths (Latin *sexagesimus*, sixtieth) they were called SEXAGESIMAL FRACTIONS. Our method of writing time and angle measure is a relic of this ancient plan. In the Middle Ages the fractions commonly used in trade were called common fractions to distinguish them from the sexagesimals used in astronomy. The Latin name was *fractiones vulgares*, whence the term vulgar fractions still used in England and in parts of the British Commonwealth of Nations. Our method of writing these fractions, as in $\frac{3}{4}$, was derived from the Arabs, the form $\frac{3}{4}$ being a late development, partly due to the typewriter. In the 16th century the decimal fraction (*q.v.*) appeared, with such symbols as $5\frac{1}{2}76$ for 5.276. The dot (.) was often used in England in the 18th century and found its way into the American colonies. England later changed to the form 5.276, and this was occasionally found in the United States, although the form 5.276 is now in general use.

In practical business the common fractions are generally limited to halves, fourths, eighths, and sixteenths for addition and subtraction; to these and thirty-seconds and sixty-fourths for measurements, decimals being used for finer work, and to relatively small denominators for multiplication and division. Cases like $\frac{2}{3} + \frac{3}{8} + \frac{5}{7}$ are useless relics of the past, and

those like $2\frac{3}{4} \times 7\frac{8}{9}$ or $(2\frac{3}{4} + 3\frac{8}{9}) \div 5\frac{1}{2}$ were never used in any practical work so far as known. In the first quarter of the 20th century a large amount of this useless material disappeared from the schools. In the case of $\frac{3}{4}$, we have 3 of the parts known as fourths; that is, the 4 names the kind of parts and the 3 numbers them. Hence, in the common Latin texts of the 16th century the 3 was called the numerator, or numberer, and the 4 was called the denominator, or namer. These terms have persisted in the English language, although translated into the vernacular in Germany and some other countries. See CONTINUED FRACTIONS; EXPONENT; DECIMALS. D. E. S.

FRACTIONATION, a method used in distillation practice to bring about an effective separation of the components. The process is often called rectification. The best method of carrying out fractionation is to bring into intimate contact a stream of condensing vapor and one of boiling liquid. The two streams flow in opposite directions. The device used to insure intimacy of contact is called a fractionating column. The simplest form of column consists of a tall cylinder, filled with broken stone, coke, special stoneware or metal rings, spirals, or other inert shapes, called tower packing. The vapor enters the bottom of the column, passes up through the column, and is totally condensed. Part of the condensate is removed as the product, and the balance is sent down through the column as "reflux," to provide the liquid stream necessary for the rectification process. The descending liquid stream showers over the packing, and a large surface of contact between the liquid and vapor is thus developed.

A much more effective fractionating column is the bubble-cap type. The column is divided into a number of sections by horizontal partitions. Each section is equipped with bubble-caps and downtakes. The liquid flows down from plate to plate by means of the downtakes, and across each plate. The vapor bubbles through the slots of the bubble-caps, and is brought into intimate contact with the liquid on each plate.

W. L. McC.

FRACTURES. The amount of force required to produce fractures of bone varies greatly and is influenced by the age and health of the patient, the part of the body involved, certain diseases, the presence of tumors, and so forth. In youth fractures are fairly likely to be of the so-called green-stick type, with little displacement of the bone; in the aged, the bones are more brittle, fractures occur easily, and fragmentation or comminution, with marked displacement, occurs.

Symptoms. The patient who has sustained a broken bone usually feels pain in the region of the fracture, and there is partial or complete loss of function of the part. The signs commonly are, swelling, discoloration, tenderness, deformity, abnormal motion, bony irregularity, and on movement a crackling sound or a feeling that suggests crackling. The symptoms are rarely all present, but *crackling* and *abnormal motion* in a bone are certain proofs. If the broken ends of the bone have been impacted (crushed firmly to-

gether) both these signs are absent. It is rarely necessary in modern practice, to manipulate the bone and to cause pain by producing the grating of the broken ends of the bone, or to demonstrate false motion in order to confirm the diagnosis, for the Roentgen rays permit painless and more positive information. It is generally accepted that it is advisable to examine all fractures by Roentgen rays before and after treatment. *Swelling* occurs almost immediately, due to effusion of the blood into the soft tissues.

The general condition of the injured person also influences the treatment, and physicians are called on to use rare judgment at times, first, to save the life of the patient, and, second, to obtain good healing of a broken bone. *Discoloration* (black and blue) may extend a considerable distance if the fractured bone is near the surface or it may be absent if the fractured bone is covered by large amounts of soft tissue. *Callus*, a plastic material, gathers about the site of fracture, as the swelling subsides. *Deformity* may be due to overlapping, angulation or impaction, but is often absent when little displacement occurs in the fractured part. *Tenderness* is perhaps the most constant sign in all types of fracture, and is brought on by applying pressure at the point of fracture or by indirect pressure on the ends of the broken bone. *Abnormal motion* of a fractured bone is often difficult to demonstrate, or is absent, as it is if impaction or incomplete fracture is present, if the fracture is close to a joint, or if the fracture is so situated that manipulation is dangerous or impossible.

Kinds of Fractures. Fractures, simple or closed, have no communication with the other surface of the body. Compound or open fractures have a wound connecting them with the surface of the body. Great significance is placed on this difference, for compound fractures are commonly infected and subsequently complicate treatment by drainage of pus, fever, the necessity of dressings, and so forth. Physicians, therefore, divide all fractures into these two groups, "simple" and "compound."

Spontaneous fractures accompany certain diseases and fractures may occur with very slight injury, as may also pathologic fractures, which occur in the presence of tumors. Sprain fractures, which occur about joints, due to undue strain on the ligaments, pull off fragments of bone and may result in prolonged disability.

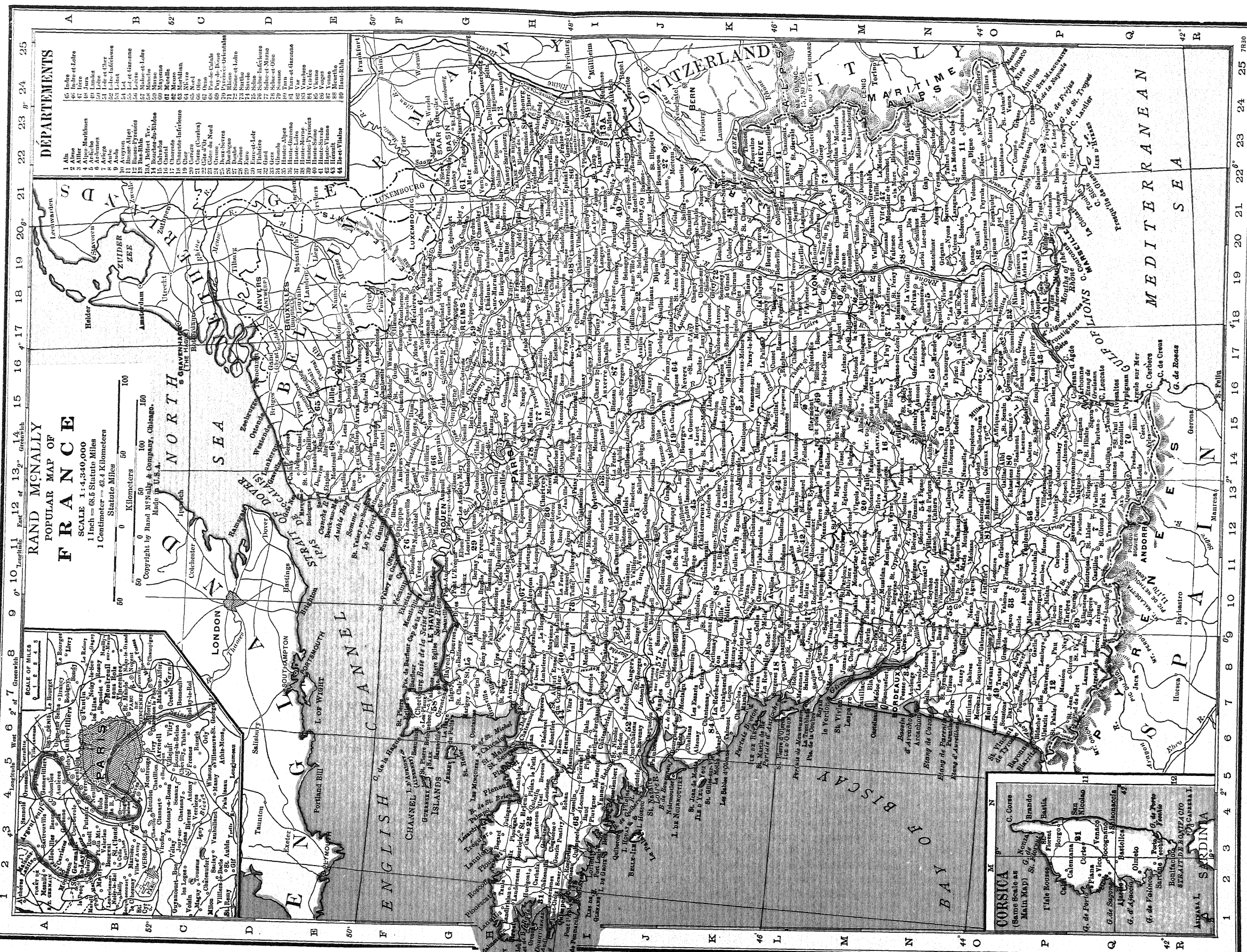
Further terms, such as "transverse," "longitudinal," "oblique," and "spiral" may be used to describe fractures. The term "fracture dislocation" indicates the presence of fracture with dislocation of a bone that forms a joint. Thus, there are combinations of terms, such as "compound comminuted fracture" which means that the bone has been broken into several pieces and a wound has been made through the skin, or a "pathologic fracture," resulting from tumor of the bone, may be also transverse. Physicians' names are associated with some fractures; the most common of these are Pott's fracture at the ankle and Colles' fracture at the wrist. The bone or bony part involved

Area 212,681 sq.m.
Pop.... 41,834,923

(Including Figures
from Latest Popu-
lation Estimates)

Pop.—Thousands
 38 Aix.....P 21
 43 Alès.....O 18
 90 Amiens....F 13
 86 Angers.....J S
 37 Angoulême

M 10
71 Argenteuil... A 3
64 Asnières... A 4
56 Aubervilliers... A 6
57 Avignon... O 20
45 Bastia... P 4
43 Belfort... I 23
60 Besançon... J 22
72 Beziers... P 16
263 Bordeaux... N 7
52 Boulogne... E 12
52 Boulogne sur
Seine... B 4
45 Bourges... J 14
70 Brest... L 1
58 Caen... G 9
70 Calais... D 13
47 Cannes... P 2
35 Carcassonne... P 14
37 Cherbourg... F 7
103 Clermont-
Ferrand... L 15
56 Coligny... I 23
47 Colmar... A 4
50 Colombar... A 4
54 Courbevoie... A 3
91 Dijon... J 19
42 Douai... E 15
51 Drancy... A 7
91 Grenoble... M 21
40 Issy-les-Mouli-
neux... B 5
49 Ivry-sur-Seine... E 4
45 La Rochelle... L 9
165 Le Havre... G 3
77 Le Mans... I 10
34 Lens... E 14
71 Levallois-
Perret... A 5
202 Lille... E 15
93 Limoges... L 12
43 Lorient... I 2
579 Lyon... O 25
801 Marseille... P 20
79 Metz... G 21
41 Montluçon... K 1
87 Montpellier... P 17
70 Montreuil-
sous-Bois... B 7
100 Nancy... I 23
121 Nanterre... E 32
40 Nanterre... B 3
187 Nantes... J 7
220 Nice... O 25
89 Nîmes... O 18
72 Orleans... I 13
37 Pantin... A 7
2841 Paris... H 14
39 Pau... P 8
34 Périgueux... M 11
74 Bergerann... Q 10
42 Poidiers... K 16
38 Puteaux... B 3
113 Reims... G 17
89 Rennes... I 6
41 Roanne... L 17
117 Roubaix... E 15
123 Rouen... G 12
Saarbrücken...
see Saarbrück
32 St. Denis... G 14
191 St. Etienne... M 19
57 St. Maur-des-
Fosses... B 8
40 St. Nazaire... J 4
53 St. Ouen sur
Seine... A 5
49 St. Quentin... F 15
105 Saarbrück... G 23
40 Sète... P 17
181 Strasbourg... H 24
32 Tarbes... P 10
133 Toulon... P 21
195 Toulouse... P 12
82 Tourcoing... E 15
79 Tours... J 11
59 Troyes... I 17
34 Valence... N 20
42 Valenciennes... E 16
67 Versailles... H 13
47 Vincennes... B 6
42 Vitry-sur-Seine... C 6



is also used to describe fractures. Thus, "intra-articular fracture" means a fracture within a joint, and a "supracondylar fracture" one above the condyles.

Complications of fractures are commonly shock, infection, delirium tremens in patients who are victims of alcoholism, and pneumonia.

Treatment. Relief of pain, prevention of complications, and replacement of the fractured ends of bone in a position which will favor their growing together calls for skilled care. It is of more importance to care for the soft tissues, nerves and blood vessels during the period of swelling than to reduce the fracture. Reduction is commonly attempted by immobilization by means of splints or plaster-of-Paris casts when patients are seen immediately after fracture and before swelling takes place. An anesthetic is usually administered to relax the muscles and relieve pain. When the fracture is properly reduced and immobilized pain should be relieved. Increased pain and swelling are danger signals and the physician had best be consulted before permanent injury can take place.

If a patient must be moved before a physician can be called, the broken part should preferably be placed on a cushion and left unbound. If it is necessary to apply a splint, it should be loosened as soon as possible and left loose until the physician arrives. If the binding is tight, and the swelling increases the tightness, the blood supply will be cut off and permanent deformity or gangrene may result. If the fracture is compound and dirt is in the wound, the wound should be left alone until the physician arrives. If it is necessary to clean the wound because the physician is so far away, an antiseptic solution should be poured into the wound and on the flesh about it before anything is thrust into the wound. Anything that is to be thrust into the wound should be boiled first. Of course, in a compound fracture, blood vessels may be so greatly injured that the patient is in danger from loss of blood. Then the bleeding is the important matter. This must be stopped, and pressure or a tourniquet, should be applied.

No definite time can be set down as that in which fractures unite, for this varies considerably with the individual patient. Solid union fails to follow some fractures; these constitute ununited fractures. Then operation and bone grafting is required. In bone grafting pieces of bone are taken from one part of the body, are placed across the site of fracture and are firmly fastened there.

Traction is one element of treatment in fractures of long bones, such as those of the leg. Weights are attached to pull on the extremity; thus the muscles are stretched and bones are pulled into a straight line. When fractures cannot be properly replaced, due to interposition of muscles and soft tissues, it is sometimes necessary to perform open reduction; that is, an operation to expose the fragments, so that they can be put together directly. It is not necessary to have perfect reduction to obtain permanently normal function.

H. W. M.

FRA DIAVOLO, a comic opera in three acts by FRANCOIS AUBER, libretto by Eugène Scribe; première, Paris, Jan. 28, 1830; first performance in the United States, June 20, 1833, New York. The military overture is frequently played in concert. The setting of the opera is the bandit-ridden country near Terracina, Italy, in the 19th century, and deals with the unsuccessful attempts of the Marquis of San Marco, a robber in disguise, to rob an English peer and compromise his wife.

FRAGONARD, JEAN-HONORÉ (1732-1806), French painter, was born at Grasse, Apr. 5, 1732. His training under Chardin, Boucher, the younger Van Loo and Natoire had less effect upon his art than the paintings of Tiepolo, seen during a visit to Venice, or a summer spent in the enchanting gardens of the Villa d'Este at Tivoli. Fame followed fast upon Fragonard's return from Italy to Paris in 1761. His *Coréus et Callirhoé*, purchased by Louis XV, was reproduced at the Gobelins tapestry factory and henceforth the king's favor determined the artist's style. One of the finest and most characteristic of the Louis XV painters, "Frago" was obliged to restrain his subject matter to the gay and frivolous topics appropriate to a pleasure-loving court, though neither King nor Court could curb his exquisite palette or affect his fine use of paint. With the Revolution Fragonard lost his royal patrons. He died at Paris, Aug. 2, 1806, alone, neglected and reviled as a corrupter of morals by artists his inferior in both imagination and technical skill. Fragonard's canvases bring increasingly high prices; in 1929 *Les Baigneuses* was sold in London for £577.

FRAMINGHAM, a town including Framingham and several other villages in Middlesex Co., eastern Massachusetts. Framingham village is situated on the Sudbury River about 21 mi. southwest of Boston and is served by three railroads and by bus lines and airports. The town has numerous factories making chiefly paper products, shoes, rubber goods and carpets. It was estimated that the value of the manufactured output for 1929 was worth about \$32,000,000. Framingham has more than 75 farms within its limits, whose chief crops are vegetables. A state arsenal, and the first state normal school in America are in the town and the state reformatory for women is at South Framingham. The town was founded in 1662 and was incorporated in 1700. Pop. 1920, 17,033; 1930, 22,210.

FRANC, a monetary unit of France and Switzerland. The French franc at par is equivalent to about 3.91 cents in United States currency, and equal to 100 centimes, while the Swiss franc is equivalent to approximately 19.3 cents.

FRANCE, ANATOLE (1844-1924), French writer, whose real name was Jacques Anatole Thibaut, was born in Paris, Apr. 16, 1844. His father was a bookseller, and the future author acquired much erudition from the wide range of books at his disposal. But he lacked industry, and it was not until he was 37 years old that his first novel, *Le Crime de Sylves-*

TRE BONNARD, saw publication. The book was immediately successful, and Madame Arman de Caillavet, a woman of wealth and intellectual brilliance, now used her influence over the author to induce him to work. A stream of novels, criticism, history, satire, and finally personal reminiscences began to flow from France's pen, his output covering a period of about 40 years. The best known of his novels are *Les Dieux ont Soif*, *Thais*, 1890, *La Rôtisserie de la Reine Pédauque*, 1893, *Crainquebille*, *Le Lys Rouge*, *L'Île des Pingouins*, 1908, *La Révolte des Anges*, 1914, and the author's reminiscences, *Le Petit Pierre*, 1918, and *La Vie en Fleur*, 1922. With these, and other books, including a *Life of Joan of Arc*, his prestige became immense both in France and abroad. Always anti-clerical, he later became a socialist, and his support was eagerly sought by and given to various radical and progressive movements; he was a prominent defender of DREYFUS. Anatole France is supreme as a literary artist. Writing his language in a manner that Voltaire, Rousseau and Renan did not surpass, his grace, simplicity and extreme clarity have become bywords among writers. Learned, witty, tolerant, sceptical, he possessed to the full the secret of charm; but while amused by his mischievous thrusts, the reader is seldom allowed to forget that France is profoundly aware of the sorrow, injustice, vicissitudes and uncertainties of human life. In 1921 he was awarded the Nobel Prize for literature. France died at Tours, Oct. 13, 1924.

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FRANCE, one of the most important countries of western Europe. It is bounded on the north by the English Channel—called by the French *La Manche*—the Straits of Dover and the North Sea; on the northeast by Belgium and Luxemburg; on the east by Germany, Switzerland and Italy; on the south by the Mediterranean and Spain; on the west by the Bay of Biscay or *Golfe de Gascogne*, and the Atlantic Ocean.

Surface Features. Tracing the general contours of France, the projections and indentations which occur are so numerous that the country assumes the shape of a polygon. The coastline is approximately 1,304 mi. long on the English Channel and the Atlantic, and 456 mi. in length on the Mediterranean. Followed from Belgium to the Pyrenees on the west, or from the Pyrenees to Italy on the southeast, it is a long succession of capes, headlands, beaches, gulfs, estuaries, cliffs and islands. Sandy beaches run with few interruptions in the northern part from the frontiers of Belgium to Cape Gris-Nez, the headland where the English Channel begins; here also lies the verdant region of Boulonnais. Beyond the estuary of the Somme, the coast assumes a grander aspect and high chalk cliffs rise to several hundred feet, ending at Cap de la Hève, at the mouth of the Seine. Golden sands and green hills then appear, providing locations for some of the most famous of French resorts, including the unique Mont-Saint-Michel, until the wild coast of Brittany is reached.

The southern coast of Brittany is less rugged as it faces the Atlantic. Near the Pyrenees the mild silver coast of sand appears. Fashionable watering places and villas dominate the strand. East of the Pyrenees the coast becomes gradually the famous French *Riviera*, broken only by mountains at the delta of the Rhône, a sun drenched strand below dark forest clad hills which gleam with white limestone and red porphyry from the harbor of Toulon to the borders of Italy.

Among the great rivers of France are the Seine, Loire, Dordogne, Garonne, Marne, Rhône, Saône and Rhine, the last being shared with Germany. The great European watershed which divides the waters that run into the Mediterranean and the Atlantic Ocean passes across France from southwest to northeast and divides it into two very unequal parts. North and west of the watershed are the basins of the Rhine, Seine, Saône, Marne, Loire and Garonne. Most important secondary basins on this side of the watershed are those of the Somme, Orne, Vilaine, Charente, and Adour. Few French rivers are navigable to large vessels for long distances. Shifting sand-banks and obstructed entrances often interrupt traffic.

Lakes are few in number and limited in extent. The largest, Grand Lieu, covers an area of less than 30 sq. mi.; the next in size, St. Point in the Jura does not cover 3 sq. mi. The few others derive their interest from their locations in the lofty regions of the Pyrenees or in ancient craters in Auvergne. Two great gulfs or bays deserve mention, namely, the Bay of Biscay and the Gulf of Lyons, the former with a breadth of 250 mi. and the latter with a distance across its mouth of about 130 mi. Others of less size are Cancale and St. Brieuc in the north, Brest, Douarnenez, and Audierne on the west of Brittany, La Forest, Quiberon, and Penefer on the south of Brittany, Bourgneuf, La Rochelle, and Arcachon farther south, and Toulon, Cavalaire, Grimand, Napoule and Juan-les-Pins on the Mediterranean.

The Alps in the east and the Pyrenees in the southwest connect the mountains of France with the most magnificent ranges of Europe. The loftiest summits are Mt. Blanc, 13,819 ft. in height, located on the borders of Savoy, and Mt. Néthou, 11,168 ft. high, in the Pyrenees. The Cévennes Range extends about 360 mi., but the average height of its central ridges does not exceed 3,000 ft. The chain of the Vosges Mountains extends in France about 100 mi., averaging 3,000 ft. in height, possessing three summits in excess of 4,300 ft. A chain of high ridges stretching south connects the Vosges with the Juras.

Climate. Although displaying some diversity of temperature and rainfall, the climate of France is very healthful. The country lies within the more moderate portion of the temperate zone, the mean annual temperature between the north and south varying only ten degrees. The northern winters may be rigorous, but in the south the olive and grape flourish and the cold is of short duration. The mean annual quantity of rain in the south is 23 in., which is one

in. more than that received in the north. Along the Mediterranean coasts winds heated by the burning sands of the African deserts occur occasionally. Wind known as the *mistral* from the N.N.W. sometimes arrests vegetation by its blasts in the basin of the Rhône, while the east wind from the Alps visits unsheltered localities in the eastern departments. Allowing for all these, three-fourths of France enjoys a serene and sunny climate.

Flora. The vegetation of France is one of the most varied in northern Europe, the total number of species of native plants having been estimated at 7,000. Of the total area of the country, 136,101,760 acres, including Alsace-Lorraine, 25,170,407 acres are forest, 11,281,033 form moors and uncultivated land, and 89,222,061 acres, of which 54,755,528 are reported as arable, are under crops, fallow and grass.

Forests. The forests are chiefly in the Ardennes, Vosges, the Plateau de Langres, the Jura and in the Cévennes. The Alps and the Pyrenees are comparatively poor in timber. The pine predominates in the Vosges and the Jura, and the larch in the Alps, while in the south mulberry trees provide a foundation for the large silk industry.

Soil and Agriculture. The soil presents all imaginable varieties, rich alluvium, vegetable loam, calcareous earth, tenacious clay, gravel and sand. Ordinary cereals form the bulk of the crops. In 1929 wheat occupied 12,400,000 acres and produced 87,053,000 metric tons; rye 1,960,000 acres produced 10,016,000 metric tons, barley 1,875,000 acres produced 12,851 metric tons, while oats occupied 8,767,000 acres and yielded 57,444,000 metric tons. Beets and potatoes also occupy extensive acreage, the former taking up 685,000 acres and producing 88,146,000 metric tons, while the potato acreage was 3,540,000 acres, yielding 134,290,000 metric tons. In the cultivation of the vine and in the wine industry France is often said to be unsurpassed. In 1930 there were approximately $3\frac{1}{2}$ million acres in vines, used largely for the manufacture of first class wines.

Among trees and shrubs which form objects of culture, the olive, lemon, orange, pistachio and caper deserve mention. In the districts where the vine fails, plums, pears and apples are grown in large quantities, the last mentioned providing in Normandy a fermented juice which is highly prized. The production of fruits other than for cider making in 1929 is reported in metric tons as follows: apples and pears, 188,429; plums, 27,031; peaches, 20,358; apricots, 5,352; and cherries, 38,267.

Animal Industry. The animal industry and fisheries are an important part of the nation's economic life. At the end of 1928, the farm animals were: horses, 2,936,620; mules, 166,280; asses, 249,700; cattle, 15,005,080; sheep and lambs, 10,415,010; pigs, 6,016,940; goats, 1,372,200. French fishery statistics for 1928 including those of Algeria, show a total of 136,779 persons employed, with an equipment of 16,766 sailing boats, 557 steamers, and 5,406 motor boats, and fishery products valued at 1,071,164,000 francs.

Mineral Resources. The principal minerals produced are coal, iron ore, rock salt, lignite, bauxite, pyrites, potash salts and mineral oil. The coal fields of France are limited in extent compared with those of other nations. The coal and iron industries combined employ over a quarter of a million men. According to the TREATY OF VERSAILLES France obtained from Germany as a compensation for the destruction of the coal mines in the north of France the exclusive rights of exploitation of the coal mines in the Saar basin. The area of this district is about 751 sq. mi. At the end of a 15-year period, the population of this area, 657,870 in number, will vote for union with France or Germany, or for the continuance of the present status. In 1929 there were mined in France 53,736,000 metric tons of coal and 51,020,000 metric tons of iron ore. The output of iron and steel products in 1930 included 10,098,000 metric tons of pig-iron and 9,402,000 metric tons of worked steel. The quarries of France produce granites from Finistère and marble from the Pyrenees, Mayenne and the Ardennes.

Manufactures. The principal manufactures of France are sugar, alcohol and cotton. In 1928-29 the 110 sugar factories employing 27,196 men, 995 women and 359 children produced 815,861 metric tons of refined sugar. Alcohol was produced in 1928 to the extent of 47,360,000 gals. The cotton industry in 1929 employed 212,160 operatives working 11,754,400 spindles, 208,200 looms and 286 textile printing machines producing 298,000 tons of yarns and 1,345,000 metres of piece goods. Silk culture, which with state aid is carried on in 24 departments of the country, notably in Gard, Drôme, Ardèche, Var and Vaucluse occupied the time of 49,514 producers in 1929, and the value of the product was 43,374,000 francs.

Commerce. Of imports for home use and exports of French origin, the chief articles listed in rotation of value in 1930 were: Imports, including coal and coke, raw cotton, wool, machinery, petroleum, wine, cereals, oil seeds, copper, coffee, hides and skins; exports, including chemical products, silk, iron and steel, cotton textiles, clothing and wine. The United States heads the list of countries from which imports come, followed closely by Great Britain. Other lands chiefly interested are Germany, Belgium, Italy, Brazil, Spain and Switzerland. As purchasers of France's exports, the United States is third in the list, coming after Great Britain and Germany.

Transportation. In 1928 the French mercantile marine had a gross tonnage of 3,441,000, while the shipping statistics for 1930 show that 9,564 French vessels with a tonnage of 14,947,360 entered the country and 8,371 French vessels with 12,695,579 tonnage cleared with cargoes. On the other hand, 22,748 foreign vessels with 46,043,449 tonnage entered and 17,313 vessels of the same group with 38,356,032 tonnage departed. The movement was distributed between the ports of Marseilles, Le Havre, Cherbourg, Bordeaux, Boulogne, Dunkirk, Rouen, Calais, Nantes, St. Nazaire, La Rochelle, Dieppe, Cette and Caen.

Tourism. A not unimportant industry of modern France is known as Tourism, a traffic of visitors from all parts of the world which throngs the country throughout the year, much of which originates in the United States and Canada. United States commercial attachés and consular officers have estimated that tourists from the United States spend annually in France approximately \$150,000,000. This becomes an important factor in the balancing of international payments.

Tourists to France, unlike those to other countries, usually limit their visit to the capital, making Paris one of the most cosmopolitan cities in the world. Others visit the coast, the spas, the mountains and a few of the more interesting smaller cities. The chief resorts on the Channel extend from Calais to Berck in Picardy, from Treport to Granville in Normandy and from Cancale to Brigogan in Brittany. The most famous stopping places in this region are Boulogne, Etretat, Deauville, Carteret, Saint-Michel, Saint-Malo, and Saint-Briac. The resorts on the Atlantic coast run from Morgat to Hendaye. One of the most fashionable is Biarritz. One of the most renowned coastlines in France is on the Mediterranean from Banyuls-sur-mer to Menton, which includes the famous *Côte d'Azur* or Riviera with its equally famous spots, Hyeres, Cannes, Juan les Pins, Nice and Monte Carlo. Numerous mountain resorts are visited in the Vosges and the Juras, also in the Alps of Savoy where Chamonix is probably the best known; in the Dauphiné Alps, where St. Pierre de Chartreuse, and Briancon are famous; in the Pyrenees Font-Romeu is frequented as well as Pau in the foothills, and also numerous points in the Cévennes. Mineral springs draw thousands of tourists every year to Vichy, Vittel, Evian, Aix-les-Bains, Luxeuil, Miers, Luchon, Chatel-Guyon, Royat, Plombières and many other similar places.

The ordinary tourist seeking neither the exhilaration of Paris life nor the attractions of the coast and spas wanders over the country seeking quaintness in Normandy and Brittany, in the ancient Roman memorials of Provence, in the châteaux of Touraine, or he may spend hours with the architecture of, or with subjects of historic interest in, such cities as Rheims, Rouen, Chartres, Carcassonne, Orange, Tarascon, Caen, Avignon and Strasbourg.

Communications. In 1928 there were 24,426 mi. of national roads, 7,572 mi. of departmental roads, 350,030 mi. of local roads, making a total of 382,028 mi. The navigable waterways in 1925 totalled 6,796 mi., transporting a traffic that year of 37,105,000 tons. The length of the principal rail lines in 1930 was 26,177 mi., comprising 5,665 mi. of state lines, 2,394 of the north line, 3,142 mi. of the east line, 4,681 mi. of the Paris Orléans line, 6,169 mi. of the Paris Lyons Mediterranean line, 2,694 mi. of the Midi line, and 1,432 mi. for Alsace-Lorraine. The total receipts in 1930 for the seven lines amounted to 15,399,576,000 francs. The electrification of rail lines is now being rapidly developed. The airways statistics for 1929

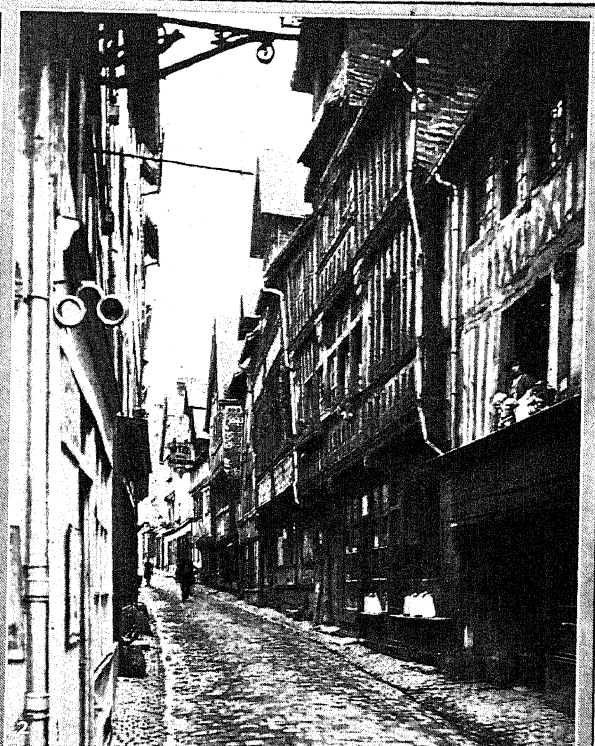
show that 5,672,000 mi. had been flown with carryings as follows: passengers, 25,289; freight, 3,532,000 lbs.; mail, 314,000 lbs. The receipts from posts, telegraphs and telephones in 1928 amounted to 2,918 million francs, while expenditures totaled 2,984 million francs. The number of ordinary letters was 1,543,000,000; registered letters, 73,000,000. The total length of the telegraph lines was 221,427 miles, which dispatched 46,214,565 telegrams, of which 11,549,458 were international. Gross telegraph receipts amounted to 329,000,000 francs. The number of telephone subscribers in 1928 was 929,485 conducting 739,676,777 conversations over 119,864 mi. of lines.

Finance. The Bank of France, founded in 1800, has the monopoly of issuing bank notes and is under state control. The capital of the bank is fixed at 182,500,000 francs. Its condition as reported on Feb. 27, 1931, was as follows: gold 55,923,598,000 francs; silver 684,616,000 francs; advances to the state 3,200,000,000 francs; notes in circulation 78,947,329,000 francs. At the end of 1929 the ordinary savings banks of the country numbered 560 with about 1,800 branches and the number of depositors totalled 9,314,766, their deposits amounting to 20,313,342,754 francs. The national savings banks on Dec. 31, 1928 held a total of 9,084,853,412 francs due to 8,131,406 depositors. The nominal value of French money coined in France in 1930 was as follows: silver 369,861,630 francs; nickel and bronze 10,934,444 francs. With the passage of the monetary law of 1928 the franc was stabilized on a gold basis. The bank of France is compelled to keep a reserve of gold bullion and coin equal to at least 35% of the combined total of the notes in circulation and the credit current accounts. The 5, 10 and 20 franc notes of the Bank of France will be withdrawn from circulation before Dec. 31, 1932, from which date they will cease to be legal tender, and the Mint on behalf of the state will issue silver coins of a nominal value of 10 and 20 francs. The franc of 100 centimes is the monetary unit of the country. Before the World War it had a value of 19.3 cents in United States currency, but in 1932 its par value was approximately 3.92 cents.

The budget estimates for the French government's fiscal year, Apr. 1, 1931-32, are as follows:

<i>Revenue:</i>	
Taxes	42,803,470,400 Fr.
Monopolies, State Indus.	656,287,682 "
State Domains	476,245,300 "
Various	6,119,781,947 "
Exceptional Revenue	165,000,000 "
Algerian Revenue	30,963,000 "
<i>Expenditures:</i>	
Finance	25,218,746,655 Fr.
Military	6,490,631,680 "
Naval	2,856,511,533 "
Air	2,262,852,020 "
Education	3,009,243,896 "
Foreign Affairs	292,320,240 "
Labor and Health	2,078,673,310 "
Agriculture	634,191,200 "
Public Works	2,263,295,174 "
Colonies	714,362,472 "

FRANCE



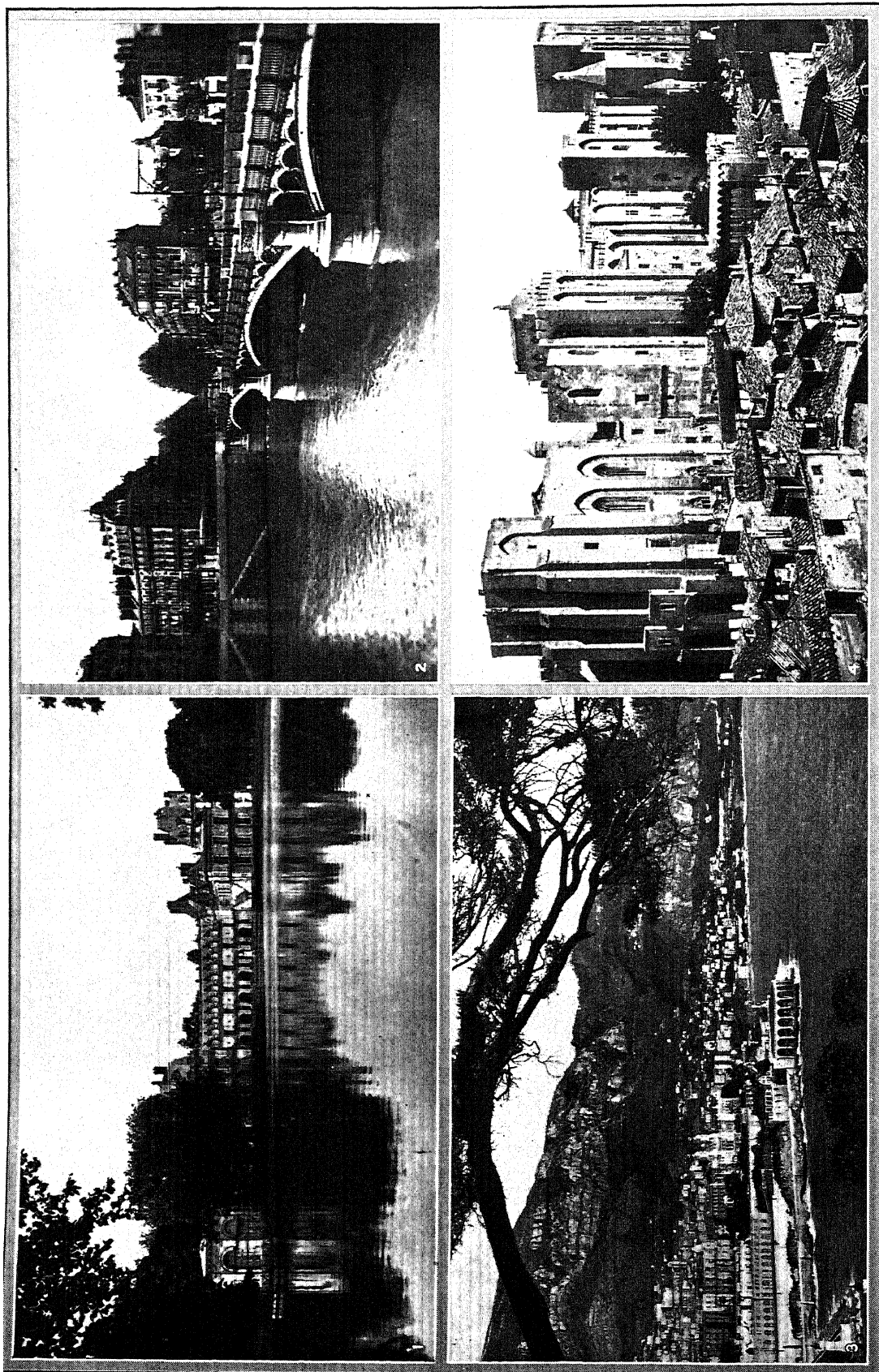
1, 3, 4, COURTESY FRENCH LINE; 2, RAILWAYS OF FRANCE

ANCIENT LANDMARKS OF FRANCE

1. Interior of the Cathedral of Rouen, built in the 13th century. 2. Half-timbered houses in a cobble street in

Lisieux. 3. The picturesque Rue St. Romain in Rouen. 4. Fishing boats at the quays of Brest.

FRANCE

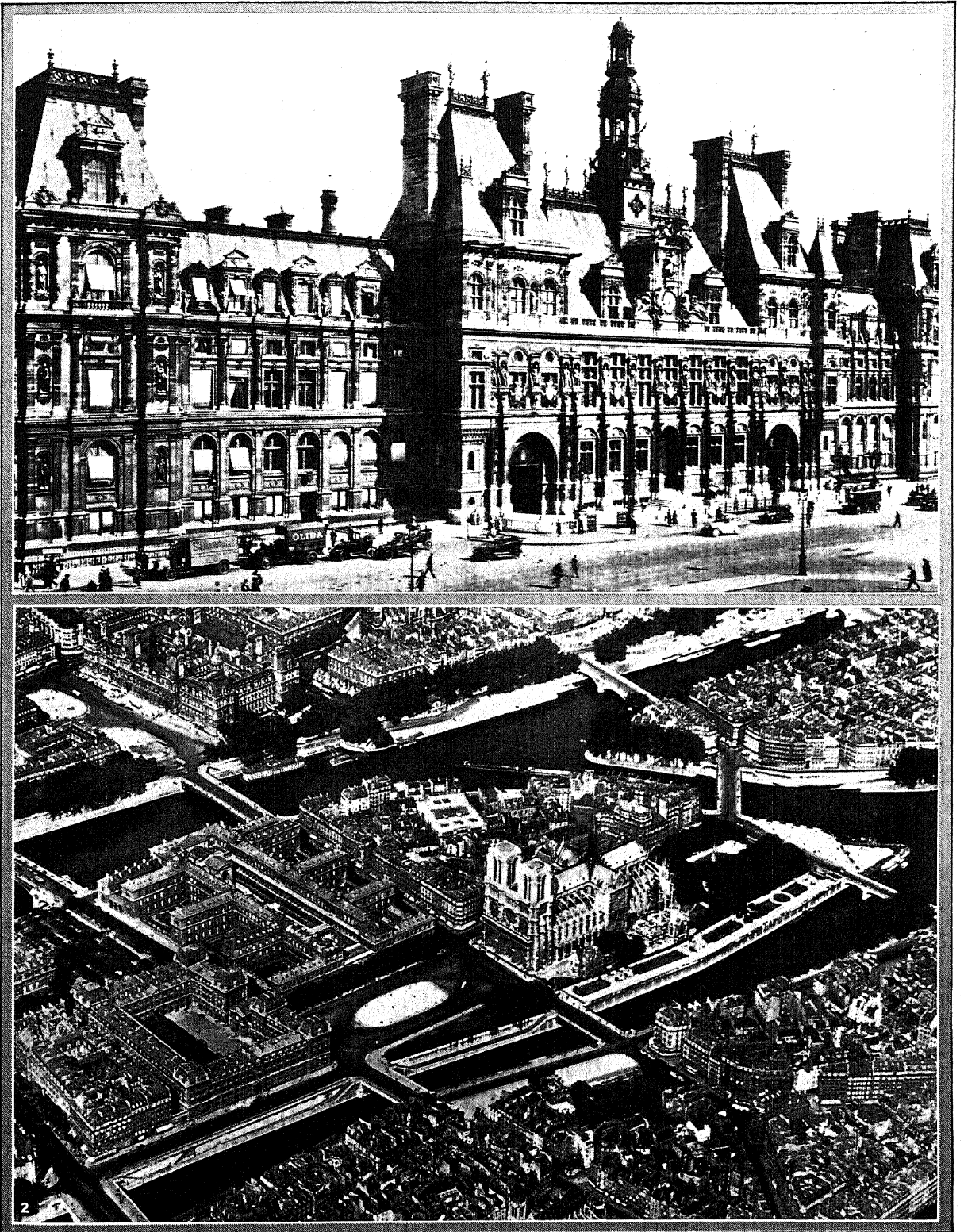


1, 2, 4, COURTESY FRENCH LINE; 3, M. T. BOWNEY PHOTO

FONTAINEBLEAU, THE CITIES OF SOUTHERN FRANCE AND MONACO

1. Palace of Fontainebleau, built in the 16th century. 2. Pont de l'Esplanade et Cours St.-Andre, Grenoble.
3. Monte Carlo, Monaco, famous for its gambling *Casino* and fashionable life. 4. Lofty walls of the Palace of the Popes at Avignon, dating from the 14th century.

FRANCE

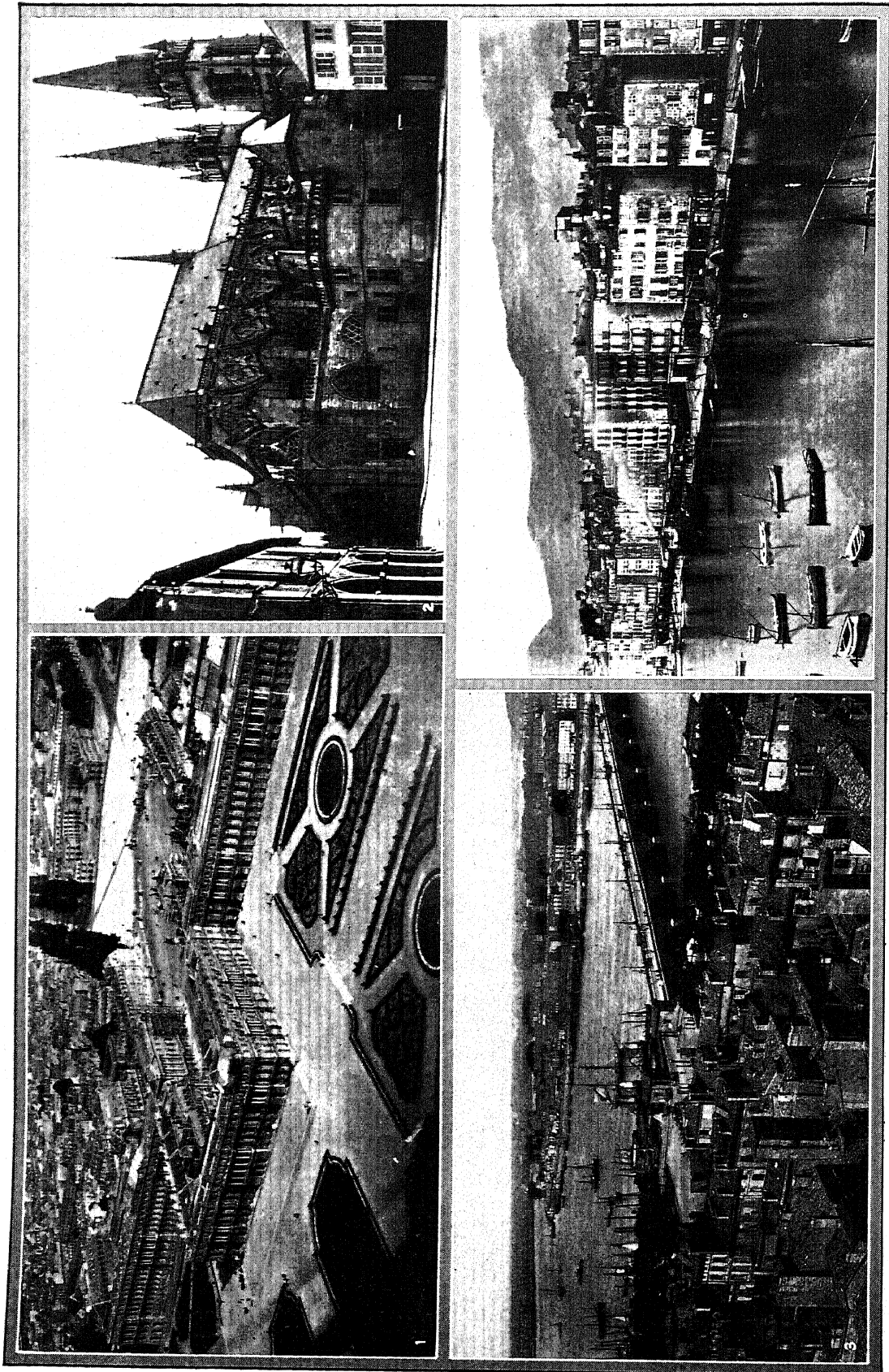


1. COURTESY FRENCH LINE; 2. BY BURTON HOLMES, FROM EWING GALLOWAY

HÔTEL DE VILLE AND NOTRE DAME, PARIS

1. Hôtel de Ville, or the City Hall, of the French Renaissance, housing the municipal government of Paris.
2. An aerial view of the Ile de la Cité, upon which is located Notre Dame.

FRANCE



1. ORIENT AND OCCIDENT PHOTO. 2. COURTESY RAILWAYS OF FRANCE; 3. 4. FRENCH GOVERNMENT TOURIST INFORMATION BUREAU

MEDIEVAL AND MODERN FRANCE

1. Aerial view of the Palace of Louis XIV at Versailles.
2. Cathedral of Moulines, dating from the 15th and 16th centuries.
3. Harbor scene at Bordeaux.
4. Street scene at Toulon.

ch tables show a total revenue of 50,251,748,329 francs against an estimated expenditure of 50,145,286, francs.

The French national debt July 31, 1914 was 34,147,969 francs; Dec. 31, 1928, largely on account of the war and its aftermath this had increased to 1,000,000,000 francs. The annual charge on the foreign debt of the country comprising debts owing the U.S. Treasury, Treasury bonds of the British Treasury and various commercial debts amounted on July 31, 1930, to 448,377,000 francs. At the same time annual charge on the floating or internal debt was 417,710 francs.

Defense. The frontier of France with its 1,760 mi. coastline and its 1,665 mi. of land boundaries constitutes the basic need of the country's defense. The metropolitan army, as distinguished from the colonial army, is divided into active, reserve and territorial. In 1931 the active units of the metropolitan army consisted of 78 regiments and 30 independent battalions of infantry, 10 regiments and one battalion of tanks, 3 regiments and 3 battalions of cavalry, 67 regiments, battalions and 10 companies of artillery, 11 regiments of engineers and 14 regiments in the air forces. Inclusive of troops occupying the Saar basin and German troops in France, the present peace strength of the metropolitan army is 316,992 men. Enlistment is compulsory but provides for liberal exemptions, ice beginning at 21 years of age for one year while total duration of the active and reserve terms is 15 years. The *Gendarmerie* is recruited from the metropolitan forces and performs civil duties in times of peace. Its strength is approximately 33,000 men, one-third being mounted.

The strength of the French navy at the end of 1930 was as follows: Six first class and 3 second class battleships, one air-craft carrier, two armored cruisers, 10 cruisers, 50 dispatch vessels, 72 flotilla leaders and destroyers and 70 submarines.

The military air force consists of 36,800 men in 10 air commands with a total of 135 squadrons. The number of first line air-craft is 1,730, and there are in addition two balloon regiments. France is constructing a system of trench and fortress defense based on its experiences in the last war and largely located on the eastern frontier.

Religion. While no religion is recognized officially by the state, France is, generally speaking, a Roman Catholic country. All Catholic churches are the property of the state but the worshippers are granted the use of them. Catholic France is divided into 88 dioceses, 17 archbishoprics and 68 bishoprics. The clergy, made up of apostolic *protonotaires*, prelates and canons, is composed of 2,500 members, while parochial services of the church are cared for by 10 rectors and 9,000 vicars. By the law of 1901, the exception of certain charitable and educational orders, such as the Brothers of the Christian Mission, the Fathers of the Holy Ghost, and certain religious missions, all congregations of religious orders were suppressed. No monastic association can be

authorized without a special law in each particular case. The two principal Protestant confessions in France are the Reformed and the Lutheran, and today the various Protestant bodies have over a thousand pastors and 850 church associations joined in a Protestant Federation with headquarters in Paris. Led by a Grand Rabbi, the Jews conduct their worship in about 75 associations working under a union known as the Associations Culturelles Israelites. Also in Paris are the temples of the Greek Catholics, Apostolic Armenians, and Moslems, there being of these last about 100,000 in France and many more in the French colonies.

Education. Education in France is divided into primary, secondary and higher, each under the supervision of the Minister of Public Instruction, assisted by a council composed of five members of the Institute and 47 professors and high officials. Secondary education is given in *lycées*, of which there were in 1930 in France and Algeria, 125 for 76,038 boys and 72 for 34,707 girls. There are also about 259 municipal colleges for boys. The 17 universities of France had an enrolment at the end of 1929 as follows: Aix-Marseilles 2,301; Algiers, 1,870; Besançon 504; Bordeaux 3,608; Caen 1,429; Clermont-Ferrand 921; Dijon 1,115; Grenoble 2,988; Lille 3,074; Lyons 4,118; Montpellier 3,152; Nancy 3,440; Paris 27,350; Poitiers 1,862; Rennes 2,393; Strasbourg 2,876; Toulouse 3,960. These universities have 15 faculties of Law, 9 of Medicine, 17 of Science, 17 of Letters and a few others. An extensive system of technical education supplements the work done in both the primary and secondary grades.

Government. The government of France since 1870 has been republican, the sovereign power being exercised by the nation through universal manhood suffrage, the elected Chamber of Deputies, and the Senate. The president is elected for seven years by the Senate and Chamber of Deputies. He chooses a ministry from the two houses, although he is free to choose some ministers from outside those bodies. In the case of a vacancy in the office the two Chambers immediately elect a new president. The Chamber of Deputies, composed of 612 members, is elected for four years by manhood suffrage. The Senate composed of 314 members is elected for nine years from citizens 40 or more years of age, one-third retiring each year. The Senate is elected by indirect vote through an electoral body composed of delegates chosen by the municipal council of each commune, and of the deputies, councillors general and district councillors of the departments. In addition there are 75 Senators who are elected for life by the two united chambers.

For the administration of local government, France is divided into 90 departments, including the three departments of Algiers. Each department is under a Prefect nominated by the government. The unit of local government is the commune, of which there are nearly 40,000. Of these, 33,914 have less than 1,500 inhabitants, and only about 159 have more than

20,000 population. Each commune is governed by a council elected for six years, which in turn elects the mayor.

Population. According to the official census of 1931, the total population of France was 41,834,923, about evenly divided between urban and rural communities, the latter being slightly in excess at present but steadily declining. The acquisition of Alsace-Lorraine at the close of the war brought an addition of 1,795,100. The population of the Saar basin which France has obtained for a period of years made a further increase of 657,870. The birth rate of the country has been a subject of great interest in recent years. In 1913 there was an excess of births over deaths of 72,280, in 1929 there were 12,564 more deaths than births, although the number of still-born children between these two years had decreased from 35,987 to 27,812. According to the last census, in 1931, 17 cities had a population in excess of 100,000, the four largest being: Paris 2,891,020, Marseilles 800,881, Lyons 579,763, and Bordeaux 262,990. Many races have combined to form the French nation. France has her Italy in Provence and a small Spain at both ends of the Pyrenees. Brittany holds within itself a people akin to the Welsh of Great Britain and Normandy sends its roots back into the homes of Scandinavia. French Flanders is a cousin of The Netherlands and the Franche-Comte still recalls the empire of Charles V.

FRANCE, HISTORY OF. Although that region between the Mediterranean, the Bay of Biscay and the Rhine which is now France has certainly been peopled since Paleolithic times, and the prehistoric men who lived there have left some remarkable cultural remains, such as the cave paintings of the Dordogne and the dolmens of Brittany, French history in the sense of recorded events does not antedate 600 B.C., the approximate date for the founding of a Greek colony at the mouth of the Rhone, *Massilia*, the modern Marseilles. At this epoch Iberians and Ligurians were occupying the western and eastern parts of southern France. North of these were Celts, linguistically akin to the Irish, Welsh and Bretons, whose earlier home seems to have been in central Europe. These were the Gauls, some of whom broke into Italy and sacked Rome in 390 B.C., while others in the course of the next century established themselves in southern France, and still others invaded Greece and Asia Minor, giving their name to the province of Galatia. Presumably the population of France in this earliest historic period was already a composite of prehistoric and historic peoples upon whom the Gauls imposed themselves as a conquering minority, whose language prevailed over that of the earlier peoples, but who became ethnically merged with the latter.

From Caesar's *Commentaries*, the earliest extensive description of the Gauls, we get a picture of a people living in a well-developed stage of respectable barbarism considerably more advanced than that of the Iroquois Indians but with some similarity to the lat-

ter. They were organized in tribes which frequently united in unstable confederations. Social classes existed, aristocratic and plebeian, often in considerable rivalry, and the government tended to be oligarchic, although, as among the early Greeks, there were remnants of royalty. There was a simple town life; agriculture was practiced; some industry in pottery and metal work prevailed; a knowledge of shipping existed along the coast; and the use of money had been imitated from the Greeks and Romans. The people practiced a religion not unlike that of the latter, although cruder in form and not yet freed from occasional human sacrifice. Their peculiarity in religion was the existence of the druids, who differ from the priesthoods of the classical peoples in being organized as a sacerdotal corporation, a clergy, with aristocratic standing and judicial authority.

From Roman writers comes the delineation of those characteristics of the Gallic temperament which have become traditional: a splendid bravery often carried to the point of rashness and coupled with a disposition to extremes of rage; intelligence; sociability; eloquence, but with a tendency to boasting and garrulity; mercurial and volatile to a fault, often wanting tenacity of purpose and ability to endure reverses, with always an indisposition to submit to discipline or authority.

Roman Conquests. In the last quarter of the 2nd century B.C. there began the advance into Gaul of the Romans, whose attention had been attracted to Spain and Gaul by the struggle with Hannibal. By about 120 B.C. the lower Rhone valley and Mediterranean seaboard were conquered and organized as the province of Transalpine Gaul. It still retains the name Provence in consequence. In 118 B.C. the first Roman town in France was founded at Narbonne. At the same time Germans were pushing across the Rhine and moving southward so that the Roman Senate had to send Marius into Gaul to defeat the Cimbri and the Teutones, 102 B.C. The continuation of this German pressure offered to Caesar, when he became governor of the Roman Gallic provinces, the opportunity to increase his reputation by conquering and pacifying all Gaul and extending Roman rule to the Rhine. Beginning in 58 B.C. he subjugated the country piecemeal in a series of brilliant campaigns. The last great effort of the Gauls, led by Vercingetorix, was defeated when the latter, besieged in Alesia, was starved into surrender, 52 B.C., although resistance in local districts continued for two more years.

With Caesar's conquest the history of Gaul became merged in that of the Roman Empire. Its historical relation to the history of France is a cultural one. Probably no other province of the empire benefited so much or so permanently as did Gaul from the gradual process of Romanization which continued for 400 years. Military colonists founded new cities, and an urban culture like that of Italy became common. Agriculture, commerce and economic life in general developed on a par with that of the other

Mediterranean countries. The building of an extensive system of Roman roads, many of which are still the foundation for modern highways, bound Gaul more closely to Rome. When all the peoples of the empire became Roman citizens by the edict of 212 Roman law became the universal legal code. Without any attempt to impose their culture the Romans succeeded completely in establishing a flourishing Latin civilization. The Roman schools offered the only form of education. Roman social standards were accepted and imitated by the Gauls. A Gallo-Roman society came into existence. Vulgar Latin, the speech of the Roman populace, became the language of common parlance and the basis for modern French. Literary Latin was the recognized medium of written expression, and Gaul under the later empire produced several poets of distinction. The druids, however, were suppressed as a dangerous organization, and human sacrifices were forbidden. Christianity spread into Gaul as into the rest of the west, and in 170 there was a persecution in Lyons. By the 4th century imperial favor had given the new religion an advantage over paganism, and the missionary activity of St. Martin of Tours helped to spread the gospel among the country people.

Merovingian Period. When the Visigoths invaded Italy the withdrawal of Roman legions from the Rhine enabled the Vandals and other Germans to cross the river, 406, and began for Gaul that period of invasions which broke up the West Roman Empire. For a century German tribes moved into various parts of France. The Visigoths set up a kingdom in Spain and southwestern Gaul, with its capital at Toulouse. The Burgundians occupied the Rhone valley to which, in part, they have given their name. Most important were the activities of the Franks, a confederation of tribes from the lower Rhinelands. Under the leadership of Clovis, 481-511, these savage pagans conquered most of Gaul and part of western Germany. In 496 Clovis accepted Christianity in its western orthodox form. This made the Franks more acceptable to the Gallo-Romans than the other Germans, who were Arians, and gave to Clovis the support of the western church clergy who regarded him as their champion.

The period from Clovis to the early 8th century is called the Merovingian period from Merovius, an early Frankish king. It was one of dreary disorder, due to the custom of dividing the kingdom among the king's sons. These then fought with each other until the victor effected temporary union. In general there were four definite sections: Aquitaine; Burgundy; Neustria, the northwest, and Austrasia, the northeast. In the latter, about 700, we find a family, the Carolingians, from whom the kings selected their chief official, Mayor of the Palace, who came in reality to exercise the royal authority while the Merovingian monarchs became "do-nothing kings." In 732 Charles Martel, Mayor of Austrasia, gained new prestige by repulsing at Poitiers a force of Moslem invaders from Spain. His son Pepin the Short was bold

enough in 752 to depose the Merovingian and, with papal approval, to establish himself as King of the Franks.

Carolingian Kings. These Carolingian kings were more than French. They united all the peoples of Gaul and western Germany, by intervention on the Pope's behalf they subjugated two-thirds of Italy, while Pepin's son Charlemagne conquered and Christianized Germany as far as the Elbe and intervened in northeastern Spain. In 800 he was crowned Roman Emperor, an event which marked the beginning of the Holy Roman Empire. His reign, 768-814, was a period of effective administration and of cultural revival. This so-called Carolingian Renaissance was an educational and literary movement encouraged by the Emperor and directed by Alcuin, which served by assiduous copying to preserve a large part of the Latin classics.

The Carolingians also divided their kingdom like a private estate, and a new period of confusion followed Charlemagne, complicated by attacks of the Northmen from the sea and the Magyars from the east. These new dangers called for measures beyond the means of Charlemagne's successors. In consequence the forces of localism became more assertive, resulting in the development of the feudal system and in the eventual choice by the western magnates of one of themselves, Hugh Capet, Duke of France (the Paris region), to be king in place of the last Carolingian, 987. The last Carolingian event of large significance occurred in 912 when the Viking chief Rollo was granted the coastland at the mouth of the Seine and he with his Northmen settled down in Normandy.

The Capetians. In order to understand the medieval epoch the salient features of the feudal system (*see* FEUDALISM) must be recalled. From the 10th to the 12th centuries France was essentially a feudal state. The French monarchy came into being through the gradual enlargement of the king's domain and through the development on that domain of non-feudal methods of administration which became the organs of royal government. The royal position of Hugh Capet and his immediate successors was weak. They did have some authority over their domain, the Île de France, but over the great lords of the kingdom, the dukes of Burgundy, Normandy and Brittany, the counts of Champagne, Flanders and Anjou, who were nominally their vassals, they exercised no real control, while in the south the Count of Toulouse and the Duke of Aquitaine enjoyed almost complete independence. The kingship was elective, which meant that with every change of ruler the magnates in return for their support could gain concessions from the crown. Counteracting these weaknesses were the facts that the king, in theory at least, was the head of the feudal system, that his position, unlike that of a duke or count, had some tradition of national leadership inherited from Frankish times, that he had the support of the Church which regarded royal government as a force making for peace and

justice as against feudal turbulence, and that later the merchant class and the towns, similarly interested in law and order, gave their support to the king. The fact also that each of the great magnates was so strong proved, in the long run, an advantage to the king because they felt no need of combining as a group, as in England, to resist the encroachments of royal power until it was too late.

Monarchical development began with the elimination of royal elections. Feudalism itself had brought about the abandonment of the Frankish custom of equal division of an inheritance among the sons, because unity of the fief was in the lord's interest. Inheritance by primogeniture became the general practice. It remained for the early Capetians to secure the succession to the crown by their eldest sons by getting them elected during their father's lifetime. This required that there be a son available and it is notable, in contrast with the German dynasties, that for more than three centuries the Capetians maintained a direct line of succession. Within two centuries, however, merely through usage, the principle of hereditary succession had replaced election. In the same way the Capetians outlived many feudal families and were able consequently to enlarge their domain by escheat.

The most serious threat to the Capetian monarchy resulted from the Norman conquest of England, 1066, whereby the Duke of Normandy became King of England. Subsequent marriages added Anjou, Gascony, Aquitaine and Brittany to this territorial combination so that under the Plantagenet family all western France, while nominally held in fief from the Capetians, was united in personal union with England. The family quarrels of the English rulers enabled the French King to keep his dangerous neighbors distracted by encouraging sons against fathers and brothers against brothers.

It was under Philip Augustus, 1180-1223, sixth in succession after Hugh Capet, that French royal authority asserted itself effectively and established itself as permanently superior to the forces of feudalism. The struggle with the Plantagenets halted while Philip joined Richard the Lion-hearted on the Third Crusade; but Philip left Richard in the east and returned home to work against him. On Richard's death in 1199 his brother John's usurpation in Normandy and Anjou gave Philip the right to intervene as feudal overlord, and John's tyranny in Poitou enabled Philip, under feudal custom, to support John's rebellious vassals in the name of justice. When John ignored summons to Philip's court he was declared a recreant vassal whose fiefs were forfeited. In 1204-05 Philip occupied Normandy and all the lands north of the Loire, annexing them to his domain. When John in alliance with the Germans renewed the war Philip defeated the latter decisively at Bouvines, 1214, an event which confirmed his conquests.

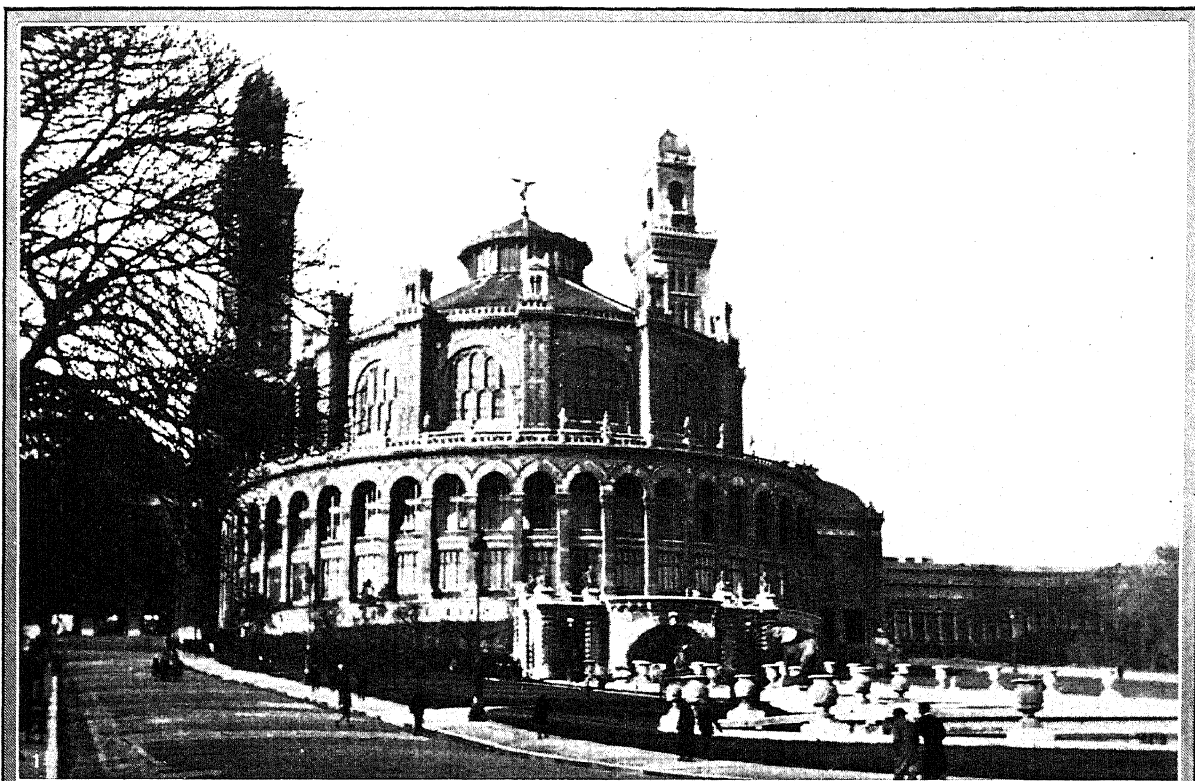
In Philip's time also, the first steps were taken towards the extension of royal authority in the south. North and south differed both in culture and dialect.

One was Languedoil, the other Languedoc, names derived from the prevailing word for yes. The more luxurious culture of the latter may have been due to contact with Moorish Spain or to inheritance from Gallo-Roman times. Its outstanding expression is to be found in the writings of the troubadours, a group of noble poets who wrote in the vernacular, or provençal, love lyrics with very ingenious rhyme schemes, the earliest examples in medieval Europe of a non-Latin, non-didactic, secular literature. During the 12th century an eastern heresy, whose adherents were called ALBIGENSES, became so popular in southern France that Pope Innocent III launched a crusade, 1208, against the count of Toulouse for harboring these heretics. The King held aloof; but many adventurers from northern France under Simon de Montfort flocked to the conquest of Toulouse. In a devastating war the count's power was broken, and by an arrangement made in 1229 the ultimate reversion of Toulouse to the rule of the Capetians was determined.

Under Philip important administrative developments occurred. Previously the royal domain had been divided into *prévôtés* in each of which a royal official collected revenue, led the vassals to war, and administered justice for the King. Under feudalism this office of *prévôt*, with land enough to support it, was granted in fief. Consequently it tended to become localized and hereditary, and so no more under royal control than other fiefs. Philip created another official, the *bailli*, to supervise and enforce royal authority upon groups of *prévôts*, an official paid with money who could be dismissed and who had no claim to make his office hereditary. By moving the *baillis* about, the King prevented their becoming identified with local interests. This created a non-feudal local administration devoted to the royal interests and readily subject to royal control. With the enlargement of the royal domain this official system was extended over more and more of France.

Assisting in the weakening of feudalism and so helping to strengthen monarchy was the development of a new class, the townsmen or *bourgeoisie*. During the 11th and 12th centuries trade revival, greatly stimulated by the Crusades, had been in progress. This encouraged the growth of towns at places favorably located for commerce. Serfs gathered together in a town became more conscious of their numbers and so more disposed to make revolutionary demands on their lords. In general these demands called for recognition of the townsmen as a group or commune with definite instead of indefinite obligations, sometimes even with a measure of self-government. This recognition was usually embodied in a charter granted to the town. In this way a non-noble class of freemen living by industry and commerce instead of agriculture came into existence. Trade required greater use of money. A moneyed class offered the king an opportunity for a non-feudal revenue in cash instead of services. To the townsmen royal authority meant more effective maintenance of order and jus-

FRANCE

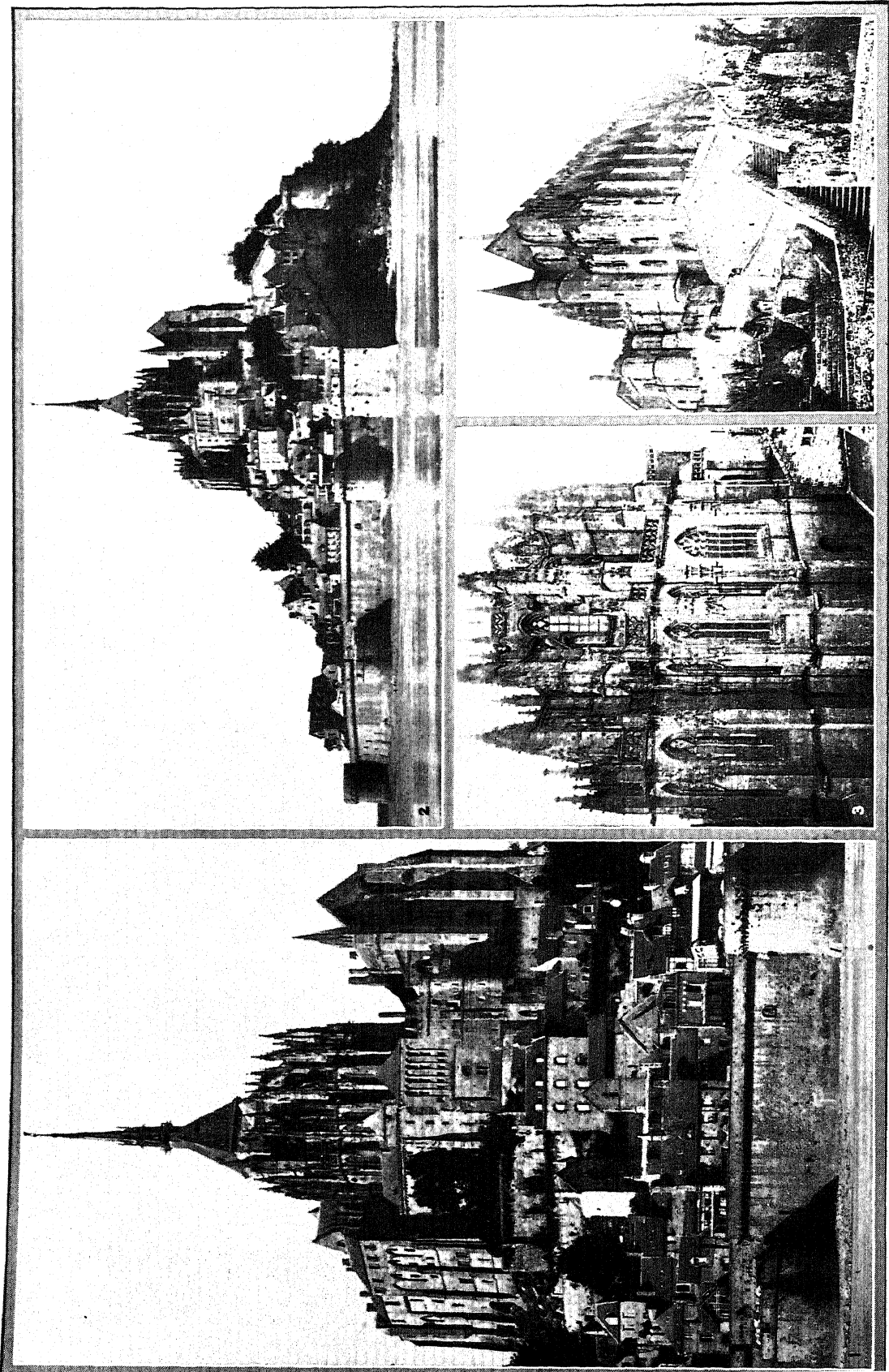


COURTESY FRENCH LINE

TWO FAMOUS BUILDINGS IN PARIS

1. The Palais du Trocadéro, housing museums of Comparative Sculpture and Ethnography.
2. The Opera House facing the Place de l'Opéra.

FRANCE



2. COURTESY FRENCH LINE

THE ABBEY OF MONT-ST-MICHEL

1. Mont-St-Michel rising above the houses of the islet.
2. Abbey from the Bay of St. Michel.
3. Flamboyant apse, with its characteristic polygonal shape.
4. Exterior of the monastic buildings called "La Merveille."

tice, so king and burghers tended to cooperate in opposing and weakening the feudal nobility.

During the 13th century the power which Philip Augustus had developed was consolidated into a national absolutism by his successors. His grandson Louis IX, 1226-70, gave the kingship the reputation for justice and uprightness which came from his practical saintliness. He encouraged appeals from the feudal to the royal courts, thereby extending his judicial authority over the whole kingdom. A revival of the study of Roman Law assisted the King by creating a lawyer class, trained in a law based upon principles of absolutism, which the King could use to man the royal courts. In that way those principles were established as part of the practical law of France.

Under Louis's grandson, Philip the Fair, 1285-1314, it became clear that a national absolutism had been created. He resumed the policy of territorial expansion by attempting to add Flanders and Aquitaine to his domain. Although these efforts were unsuccessful they were important because they were so costly that new financial expedients became necessary. When, like his predecessors, Philip levied taxes on the clergy to support his wars, in 1296, Pope Boniface VIII forbade the latter to pay. By an embargo on precious metals Philip cut off papal revenue from France, and the Pope withdrew his prohibition. The royal power over the clergy had been effectively demonstrated. When Boniface again sought to assert the superiority of papal over royal power Philip, in order to secure national support, summoned the first Estates General, 1302, a gathering of representatives of the three social classes or estates: clergy, nobility and *bourgeoisie*, to give approval to his resistance of papal claims. This institution Philip later, 1314, found useful in gaining consent to taxation. By threatening appeal to a General Church Council and by dramatic intervention in the turbulent politics of the papal principality Philip so intimidated Boniface's successors that they practically placed the papacy under French protection by moving from Rome to Avignon, 1309.

The Valois Kings. The French ambition to acquire Flanders and Aquitaine excited English hostility, since Flanders was the chief market for English wool and Aquitaine was part of the Plantagenet inheritance. When the direct Capetian line died out, 1328, another issue, that of succession to the French throne was added. In order to exclude the English King the French lawyers formulated the so-called Salic law, averring that women could not inherit the crown. The rule passed therefore to the Valois family. A long period of intermittent warfare, the Hundred Years' War, 1337-1453, followed. English archers won crushing victories over French knights at Crécy, 1346, and Poitiers, 1356. Calais was taken by siege, 1347. But Charles the Wise, 1364-80, and his constable, Bertrand du Guesclin, recovered much of what had been lost. When under Charles's insane son France became torn between rival factions of Bur-

gundians and Armagnacs the English again intervened. After Agincourt, 1415, they conquered Normandy, occupied Paris, made alliance with the Burgundians, and secured the succession to the French throne for the English King. The course of conquest was stopped when, with Joan of Arc's help, the siege of Orléans was raised, 1429; but it required more than 20 years of continuous struggle before the English were expelled from France, except Calais, and Aquitaine was added to the royal domain. The war strengthened royal power because the national emergency gave Charles VII, 1422-61, occasion for forming a permanent, non-feudal, royal army and levying a perpetual tax for its maintenance. Thus he became free from serious control by the Estates General. Furthermore since the King was the center of national feeling during a long period of national effort his authority and leadership became part of the patriotic tradition.

During this period, however, the popes were able to escape from French influence by returning to Rome, 1377. Also part of the price of victory had been concessions to the Duke of Burgundy, so at the end of the war the Burgundian state embraced considerable territory from the Alps to the North Sea and threatened to become an independent kingdom. Louis XI, 1461-83, aimed to curb this new power, and when Duke Charles the Bold was killed, 1477, Louis seized a large part of the Burgundian lands. He also secured the inheritance by the Crown of the lands held by the House of Anjou. The final step in the territorial formation of the monarchy came when Charles VIII, 1483-98, married the heiress to Brittany, the last of the great feudal states.

Almost immediately Charles launched an ambitious foreign policy by invading Italy to assert a claim to the throne of Naples. His successor, Louis XII, 1498-1515, added a similar claim to Milan. These were opposed by Ferdinand of Spain and by the Emperor Charles V. The latter was also heir to the dukes of Burgundy and to the Habsburgs, as well as being Emperor; so his territories practically surrounded France. In warring with him Francis I, 1515-47, was not only striving for part of Italy, but was also seeking to maintain French independence and to preserve the balance of European power. Although unsuccessful in Italy Francis did make a profitable alliance with the Pope, 1516, who also opposed Charles in Italy, whereby the King was empowered to nominate French prelates. This gave the Crown control over the ecclesiastical personnel and made the French church subject to the royal will. This explains, in part, the hostility of the kings to Protestantism in France. They were willing enough, however, to aid the Lutherans in Germany against Charles. Francis also made an alliance with the Turks in order to encourage attack from the east upon Charles in central Europe. By these wars against the Habsburgs France recovered Calais from England, temporarily a Hapsburg ally, and began expansion toward the Rhine by seizing Metz, Toul and Verdun.

Meanwhile the Reformation was revolutionizing the trend of European politics. Lutheranism had little influence in France; but Calvin, himself a Frenchman, gave a more universal and militant character to the religious movement. His *Institutes*, 1535, provided a logical and literary basis for French Protestantism. Although most of France remained Catholic the Huguenots, or French Calvinists, exercised a large influence because they were drawn from the wealthy middle-class with support from the provincial nobility. They tended to oppose the absolutism of the Crown, thus confirming the King's Catholicism. But the European leader of Catholicism was Philip II of Spain, a Habsburg and a dangerous enemy. To preserve the national independence from Spain and to defend the royal absolutism against the Huguenots became the problem of the last Valois kings and of their mother, Catherine de' Medici.

The House of Bourbon. The massacre of the Huguenots on St. Bartholomew's Day, 1572, was aimed at a political party quite as much as at an heretical sect. For nearly 40 years, 1560-98, France was torn by a series of religious civil wars in which Spain and England intervened on the Catholic or Huguenot sides. When, by the death of the last Valois, the question of succession also became involved, complicated by the fact that the next heir, Henry of Bourbon, King of Navarre, was a Huguenot, a Catholic patriotic party, the *Politiques*, formed, more determined to protect French independence from Philip II than to secure religious unity. A compromise resulted. Henry gained national support as King by renouncing Protestantism, 1593. He then fought successfully for peace with Spain and issued for France an edict, the Edict of Nantes, 1598, tolerating the Huguenots and giving them, as a guarantee of safety, control of certain French cities and the right to maintain a semi-political organization. France thus settled her religious problem earlier than any other European power and became free to turn to other matters.

Under Henry IV, 1589-1610, France began the development which eventually gave her the political hegemony of Europe. Aided by his minister, Sully, the King aimed to achieve national recovery from the devastating effects of civil war. Honesty and economy sufficed to restore the finances. Agriculture was assisted by the abolition of local tariffs on grain, by subsidies, and by public works such as roads and canals. The introduction of mulberry trees and silkworms inaugurated a new and important industry. Colonial enterprises were launched by French traders in India and by Champlain in Canada, 1608. With the resources of a prosperous nation at his command Henry was preparing to take the offensive against the Hapsburgs in Germany when he was assassinated.

The minority of Louis XIII, 1610-43, halted the progress of French greatness until Cardinal Richelieu became the King's chief minister, 1624. For 18 years he was the real ruler, devoting himself to the task of making the King supreme in France and France su-

preme in Europe. He eliminated the Estates General, which had occasionally shown a disposition to try feebly to act like a parliament, merely by neglecting to summon it. He cowed the nobility by destroying their castles and by ruthlessly punishing any who opposed him. Noble participation in local government was practically ended by the establishment of a new official, the intendant, recruited by appointment from the *bourgeoisie*, to whom the exercise of royal authority in the localities was largely delegated. It remained for the nobility to be content with commissions in the army or with the rôle of courtiers accepting royal favors and pensions by ceasing to be politically important. The other opponent to absolutism was the Huguenot party. Richelieu was tolerant enough in religion but resolutely opposed to a factious political organization. He seized the occasion of a Huguenot revolt, 1625, to break the Huguenot power, conducting in person the siege of La Rochelle, the chief Huguenot stronghold. The Protestants continued to enjoy religious freedom after their defeat, but lost control of fortified towns and the right to organize.

At this time European affairs centered upon the struggle in Germany, now known as the Thirty Years' War, 1618-48, and during its early stages the Hapsburg Emperor had succeeded in effecting almost a conquest of northern Germany. The menace of a united, Habsburg Germany alarmed both France and the Protestants of Europe. Victor over domestic enemies, Richelieu undertook to combat the ancient enemy in the east. With arms and money he assisted Gustavus Adolphus of Sweden to come to the aid of the German Lutherans. This turned the tide of Habsburg success; but when the Habsburgs seemed about to negotiate peace, 1635, France intervened actively in the war, against both Austrian and Spanish Habsburgs, prolonging the struggle for 13 years. The result was a French triumph. The TREATY OF WESTPHALIA, 1648, not only confirmed Metz, Toul and Verdun to France, but extended her frontier to the Rhine by securing Alsace to her with a right to interfere in German affairs. Even more important was the weakening of Germany in both a political and economic sense, freeing France from any pressure and leaving her free to encroach. War against Spain continued until 1659 and left France with enlarged boundaries, with a protectorate over Lorraine, and with the reputation for military greatness which Spain had enjoyed for a century and a half. Richelieu did not live to complete this work; but his policies were continued during the minority of Louis XIV by his ministerial successor, Cardinal Mazarin. To the latter also goes the credit for suppressing the Fronde, the last noble resistance to absolutism.

The heir to the work of Richelieu and Mazarin was Louis XIV, 1643-1715, under whom France attained a political and cultural position in Europe so advanced that the epoch is called the Age of Louis XIV. Louis personified the principle of Divine Right absolutism. He surrounded himself with grandeur,

exemplified by his new palace at Versailles which became the model for the other European courts. Under the direction of his finance minister, Colbert, the economic strength of France was increased by the practical application of mercantilist theories. He aimed to make France economically self-sufficient, to have France enjoy the supposed advantages of a favorable trade balance by selling more abroad than she bought. Protective tariffs and an active colonial and naval policy it was thought would give France the dominant position in world commerce. All this led to great rivalry with the Dutch and English. In many ways this policy did provide Louis with greatly increased revenues; but these and more too were squandered unproductively in the pursuit of magnificence and glory. France also suffered when Louis, actuated by bigotry, revoked the Edict of Nantes, 1685, causing the industrious Huguenots to migrate to Prussia, England and America.

Louis, above all things, enjoyed the practice of diplomacy particularly for the enhancement of his prestige. His arrogant demands had behind them the largest and most professional army of the day, organized by Louvois and Vauban, and commanded by Turenne and Condé. No longer on the defensive, France under Louis undertook to expand at the expense of her neighbors. To justify his aggression Louis advanced the theory that France had a right to natural frontiers, namely the Alps and the Rhine. Then, after much diplomacy, he proceeded to war against Spain, 1664-68, and Holland, 1672-78, in order to expand in the Netherlands, and against Spain and the Germans, 1688-97, for control of the upper Rhine. It is true that France gained territory by these; but the chief result was to alarm Europe which saw in France's greatness a serious threat to the balance of power. This alarm became intense when the last Spanish Habsburg willed his empire to Louis's grandson, 1700. All Europe united to prevent the union of France and Spain and defeated Louis in the war of the Spanish Succession, 1702-14. French resources were exhausted by the wars, and by the Peace of Utrecht some of the American colonies were lost to England. France remained the leading continental power but not the dominant one.

In culture also France enjoyed leadership during this epoch. The French language, French styles, French manners were accepted as the standards of good taste. Louis recognized the contribution to royal magnificence which comes from the patronage of art and letters. His age is marked by a galaxy of French writers unequalled in any other period of French history, the outstanding examples of the classical school who undertook to deal with the great human emotions in the grand manner comparable to that of the ancients. Corneille and Racine were pre-eminent in tragedy, Molière in comedy. The names of Pascal, Bossuet, La Rochefoucauld, La Fontaine and Mabillon will suggest the variety of the age.

The period following Louis XIV can best be considered as a prelude to the Revolution which brought

it to an end. In considering this, however, it should be remembered that the general social and economic conditions of France were, if anything, superior to most of the continent. What France suffered from was financial difficulty, which the Government was never bold enough to remedy. Annual deficits were met by increased borrowing until the Government's credit was exhausted. The avoidance of unprofitable wars for prestige or the balance of power, or the curtailment of court expenses were financial expedients never seriously attempted. Most of the period was filled by the reign of a bored debauchee, Louis XV, 1715-74, who permitted his mistresses to be the real power in the state. His successor, Louis XVI, 1774-92, while personally respectable, was vacillating, stupid, and dominated by his frivolous queen, Marie Antoinette. In neither set of circumstances was there much chance for necessary reforms.

International affairs had been complicated on the continent by the rise of Prussia and Russia, states disposed to grow at the expense of France's friends, Poland and Turkey. England was definitely committed to a colonial and naval policy. Only France attempted to be both a continental and a colonial power and so found herself involved in every international struggle, usually disastrously. When she joined Frederick the Great to partition Austria, 1744-48, she gained nothing. When she joined Austria to partition Prussia, 1754-63, she lost her colonial empire in India and America to Frederick's ally, England. Only in the war of American Independence, 1778-83, when she had no continental distractions, did France enjoy a triumph, and then she gained mere prestige and that by a financial expenditure which induced bankruptcy.

Simultaneously an intellectual movement stimulated by the scientific discoveries of the 17th century was revolutionizing the European point of view. It was supposed that, just as scientific laws were being discovered, so also the laws of economics and government could be formulated by rational cogitation. The French philosophers of the Age of Reason boldly attacked the problems of society, prepared to criticize all the irrational phases of the old régime. Voltaire, whose works were both numerous and popular, made scathing attacks on the Church, an easy target in the 18th century, advocating a vague "natural" religion. Montesquieu explained, somewhat erroneously, the virtue of limited monarchy as practiced in England. Rousseau preached sentimental humanitarianism, and in his *Social Contract*, 1761, set forth the principle of popular sovereignty. Rational intellectualism became the vogue. Elsewhere it led to the enlightened despotism of Frederick the Great; but French despotism lacked the intelligence of enlightenment. Thanks to the philosophers the need for reforms of many kinds was generally discussed; but nothing was attempted until the financial situation became desperate.

One suggestion to meet the financial situation was to levy taxes upon the clergy and nobility, who

hitherto had always enjoyed the privilege of exemption; but this proposal had been effectively resisted by these two classes. As a final expedient the Estates General was summoned to provide some means for avoiding bankruptcy. It met at Versailles in May 1789. Under Mirabeau's leadership the Third Estate, i.e. the commoners, took the stand that France needed sweeping reforms which could best be embodied in a constitution, and they organized as a National Constituent Assembly. When the court assumed a threatening attitude the Parisian populace cowed the King by capturing the Bastille, July 14. This was the signal for the peasants throughout France to attack the local castles in order to destroy the feudal records. In consequence the assembly, at a single session, Aug. 4, abolished the last remnants of feudalism. This marks the collapse of the old régime. Many of the nobility fled the country. In October the mob brought the royal family to Paris; the Assembly followed, thus becoming subject to mob pressure.

To meet the financial crisis the Assembly decreed the confiscation of the Church lands and issued paper money with this property as security. The clergy were to receive salaries from the state and to be elected by the people. This alienated many pious people, including the King, who otherwise were not unsympathetic to reform. On the other hand the peasant purchasers of these lands came thereby to have a vested interest in the Revolution. By 1791 the whole governmental system, including local and judicial administration, had been demolished and rebuilt along rational lines, and a constitution issued making France a limited monarchy.

The First Republic. This new Government lasted a year. It collapsed because France became involved in war in Apr. 1792. Some of the radical politicians hoped through a war to establish a republic and they wished to spread the revolutionary gospel to other peoples. The King thought war would strengthen his authority. Austria and Prussia hoped to gain territory from France weakened by revolution. These two powers, however, were very suspicious of each other and were also much occupied with plans for the second partition of Poland. Consequently their intervention in France was too half-hearted to accomplish anything except to excite the French people to a frenzy of patriotism. One phase of this was justifiable suspicion of the King, which led to an uprising in Paris, Aug. 10, 1792, which overthrew the monarchy. A National Convention met and proclaimed a republic. Meanwhile at Valmy the Prussians had been repulsed. In January the King was guillotined.

The Convention came to be dominated by the radical Jacobins, led by Danton and Robespierre. It had to cope with war against a coalition of practically all Europe, and with a revolt in La Vendée and other provinces, while at the same time governing France and continuing to make revolutionary reforms. A Committee of Public Safety with almost dictatorial

power acted as an executive. Terror was used to suppress domestic foes and political opponents. By the expedient of conscription patriot armies were formed which astonished Europe by their victories over the veteran forces of the powers. Not only did they defend the revolution but they succeeded in rapidly conquering for France the natural frontiers desired by Louis XIV. At the same time the Convention abolished slavery, separated Church and State, introduced the metric system, and took steps towards a scientific codification of the laws and a system of public education. It finally completed a constitution creating a conservative republic headed by a Directory of five, 1795.

The Consulate. This government lasted until 1799. It was weak and corrupt. Under it the army conquered northern Italy and forced peace upon Austria; but credit for this went not to the Directory but to Gen. Napoleon Bonaparte. When the latter was sent on an expedition to Egypt his Italian conquests were lost. He returned to effect a *coup d'état* which set up a military dictatorship concealed under parliamentary and democratic forms, the Consulate, 1799-1804. As First Consul Bonaparte recovered Italy, extracted peace from Austria and negotiated peace with England, 1802, bringing a decade of war to an end. This made possible the consolidation of the gains of the Revolution. Napoleon gave France real enlightened despotism. A concordat with the Pope, 1801, settled the religious question, leaving the clergy as state officials and leaving the Church lands in the hands of their revolutionary purchasers. Efficiency, economy, the practice of making war pay for itself, and the creation of the Bank of France settled the problem of finance. The Code Napoléon provided a uniform and modern legal system which became a model for Europe. The Legion of Honor offered rewards to patriotic supporters of the state. So popular was the Napoleonic work that a plebiscite approved the proclamation of an Empire with Napoleon as Emperor, 1804.

The Empire. Like Charlemagne's, Napoleon's Empire was more than French. It aimed to be continental. Neighboring states in Italy, Germany and the Netherlands, and even Poland and Spain became vassals. Austria and Prussia were forced into alliance. Only Russia was treated as an equal. England, after the renewal of war in 1804, remained an implacable foe. Unable because of the British Navy to strike directly at England, Napoleon attempted to ruin the English by excluding their commerce from the continent. The enforcement of his Continental System upon the other states necessitated a series of wars. From 1807, when Russia made alliance with him, until 1812 he dominated Europe. But the Spanish people, resenting his interference in Spain, rose in a revolt, 1808, which, aided by English armies, he never suppressed. The other states chafed under the Continental System. When Russia broke away from the system Napoleon attempted to coerce the Tsar by capturing Moscow, 1812. The result was

a French disaster of such proportions that the other states dared to turn on Napoleon. By 1814 an international army had occupied Paris. When Napoleon, exiled to Elba, suddenly returned to France and revived the imperial government an Anglo-Prussian army, by a crushing defeat at Waterloo, 1815, brought the Napoleonic period to an end.

The Restoration. The victorious allies, hostile to the traditions of revolution and Napoleon, restored the Bourbon King as the most expedient policy. Louis XVI's brother, consequently, was recognized as King Louis XVIII. (Louis XVI's son, who died in prison during the Reign of Terror, was regarded as Louis XVII.) In order to make this régime less unpopular, relatively easy terms of peace were imposed upon France. She lost only the territory conquered since 1789. An indemnity was imposed, and she had to submit until 1818 to an army of occupation. The political settlement made by the Congress of Vienna aimed, in part, to prevent future aggression from France.

Louis XVIII, 1814-24, although a Bourbon, was sufficiently practical to see the wisdom of compromise with the principles of the Revolution. He issued a constitutional charter which provided a government similar to the English. Indeed the franchise was even more liberal than that prevailing in England. The practical reforms made since 1789 were accepted despite the fact that an ultra-royalist group, led by the heir apparent, clamored for a more complete return to the old régime. Prompt payment of the indemnity freed France in three years from the armies of occupation, while a conciliatory and conservative foreign policy secured for her a place in the Concert of Europe. This recovery of prestige was demonstrated in 1831 when French armies, in the name of Europe, intervened in Spain to overthrow a revolutionary constitution; and five years later France was able to start the conquest of Algiers. At home this period was one of political education. The issues were those of practical liberalism, namely the details of personal liberty, freedom of the press, the franchise, and public education, issues which remained phases of French politics for the remainder of the century. Could the conciliatory attitude of Louis XVIII have been continued the restored monarchy might have lasted. But the accession of Charles X, 1824-30, brought to power a doctrinaire reactionary determined to effect a more complete restoration of the old régime and particularly to provide compensation to the clergy and nobility for the losses suffered during the Revolution. Such procedure was so unpopular that the elected Chamber repeatedly voted against the King's ministers and the royal policies. This raised the issue of ministerial responsibility, and with it that of the ultimate power to determine policy. Did it lie with the King or the Chamber? When, by decree, the King sought to gain his end by altering the franchise to secure a compliant Chamber Paris rose in insurrection, July 1830. Charles, remembering 1792, fled.

This revolution of 1830 eliminated legitimate absolutism from French politics. To forestall the advocates of a republic certain bourgeois leaders, including Thiers, proclaimed a liberal monarchy under the King's cousin, Louis Philippe of Orleans, with the tri-color flag of the Revolution as the emblem. This new government was supported by the middle-class capitalists who were becoming increasingly important as the Industrial Revolution began to influence French economic life. These wanted policies favorable to business, such as peace, tariff reform and property qualifications for voting. The issue of ministerial responsibility approached practical solution without being accepted in principle. Thiers advocated full responsibility to the Chamber; but his political rival, Guizot, avoiding the principle, undertook to carry out the King's policy by controlling a majority in the Chamber through various forms of corrupt political manipulation. Agitation for reform to eliminate corruption became a demand for a more democratic franchise. The stupidity with which Guizot resisted this led, in Feb. 1848, to an unexpected uprising in Paris which frightened Louis Philippe into abdicating.

The Second Republic. The revolution of 1848 was startling both in its suddenness and in its manifestation of the fact that new revolutionary forces bred of the Industrial Revolution were afoot. The bourgeois liberals demanded a republic and they were joined by the industrial proletariat of Paris demanding Socialism in addition. This latter was a new specter more terrifying than Jacobinism. Lamartine and Louis Blanc represented the two groups in the provisional government which proclaimed the Second Republic. To meet the unemployment problem the new Government accepted the principle that every worker had a right to work and established national workshops. The provinces, however, were not proletarian and elected a constituent assembly hostile to Socialism which abolished the workshops and crushed ruthlessly a workmen's uprising. The fear of social revolution and the general desire for law and order caused the electorate to choose for the presidency a silent man with a name which seemed a guarantee of strong government, Louis Napoleon Bonaparte, nephew to the Emperor.

The new President was a humanitarian, philosophical adventurer with considerable political shrewdness but without his uncle's capacity for statesmanship. He aimed to establish a popular dictatorship, a government which cared for the interests of all classes. He was willing to dabble in Socialism. He was also willing to please the Catholics by restoring the Pope whom Mazzini had expelled from Rome. Championing universal suffrage against a conservative assembly, he became sufficiently popular to dare a military *coup d'état* Dec. 1851, which set up a practical dictatorship confirmed by plebiscite. A year later he was proclaimed Emperor Napoleon III. (Napoleon I's son, who died without reigning in 1832, was regarded as Napoleon II.)

The Second Empire. For the first few years the Second Empire was a success. Some forms of democracy were maintained and skillfully managed to produce the realities of absolutism. Social legislation for workingmen was initiated, and at the same time policies favorable to business were pursued. The Algerian conquest was completed and a colonial empire in the Far East started. Diplomatic prestige and military glory were gained in the Crimean War, 1854-56, waged with England against Russia for the protection of Turkey. At the Congress of Paris Napoleon appeared as the arbiter of Europe. In this rôle and as an advocate of the principle of nationality he turned to the problem of Italian unification. In alliance with Sardinia, French armies drove the Austrians out of Lombardy, 1859; but Napoleon then lost control of the situation. The Italian people carried through a more far-reaching unification than France desired, and the Emperor was unable to prevent it. This failure alienated public opinion in France. Napoleon's neglect of the insurgent Poles, 1863, damaged his reputation. His intervention in Mexico, 1862-67, followed by a dishonorable withdrawal at the order of the United States was disastrous. Since the Empire rested upon prestige something had to be done to restore its popularity. A series of liberal reforms, 1869, it was hoped, would gain political supporters, while a vigorous foreign policy in Germany would revive the imperial reputation. Here, however, Napoleon encountered Bismarck, who goaded France into declaring war. The Prussian armies rapidly invaded France. Napoleon was defeated and captured at Sedan, Sept. 2, 1870. Two days later the Third Republic was proclaimed in Paris.

The Third Republic. Under Gambetta's leadership a Government of National Defense fought heroically in the defense of Paris against the Prussians; but the capital was starved into surrender, Jan. 1871. To negotiate peace it was necessary to elect a National Assembly. Since on the issue of peace or war the monarchists stood for peace they gained a majority, although probably the people favored a republic. By the Treaty of Frankfurt France ceded Alsace and a part of Lorraine to the new German Empire and submitted to an indemnity which Bismarck erroneously believed would be difficult to pay, while under the burden of supporting a German army of occupation until it was paid. It was an onerous and humiliating peace, and the annexation of Alsace-Lorraine was rightly regarded as a violation of the principle of nationality. French patriots hoped for a day of *revanche*.

The new republican Government seemed an uncertain and unstable affair in 1871. Even before peace with Germany was completed it was faced with violent and radical resistance from Paris where Socialist leaders organized the Commune and declared it independent of the Assembly. The latter, avoiding any reference to a republic, chose Thiers chief of the executive power. With the armies released from Ger-

man imprisonment Paris was again besieged and stormed. The Commune was destroyed with all the ferocity of class warfare. The Assembly then assumed power to govern France and to make a constitution. It was unable, however, to set up a monarchy because there were three pretenders to the throne, the heirs of Charles X, of Louis Philippe, and of Napoleon III, each with his adherents. When, at one time, the first two effected an agreement the restoration was balked by the Bourbon refusal to accept the tri-color flag. Unable to agree the Assembly reluctantly elected Thiers President of the French Republic and enacted organic laws but of so conservative a character that by amendment a king could be substituted for the president. On paper the powers of the president are considerable, and it took a constitutional crisis, 1877, to establish the tradition that the ministry is responsible to the Chamber and that the latter is the real power in determining policy. The president, in consequence, has become a figure-head. By 1880 the republicans were in complete control of the government.

A democratic system, however, is always subject to the evils of party politics and to this France was no exception. This gave opportunities for charges of inefficiency and graft which the enemies of the republic did not neglect. At one time, 1889, there was danger that a popular general, Boulanger, would be able to effect a military *coup d'état*; but he lacked the necessary Napoleonic nerve. Monarchist sentiment flourished particularly in the army and the Church. In a violent controversial scandal known as the Dreyfus Affair, 1894-99, the efforts of the monarchists to discredit the republic failed. Indeed they served to unite the republicans and to cause them to take steps to assure republican control of the army. Ever since 1790 the Church had been the ally of the monarchy, and from an early date Gambetta had seen in clericalism an enemy to republican institutions. Having weathered the Dreyfus Affair the Government felt emboldened to discipline the clergy. Legislation was passed, 1901-04, which resulted in the exclusion from France of many religious orders and which led to a more complete secularization of education. This was followed in 1905 by the abrogation of Napoleon's concordat and a complete separation of Church and State.

In foreign affairs the Third Republic suffered from diplomatic isolation. Bismarck encouraged France to turn her attention to the colonial field where she would get into trouble with other imperial powers such as England and Italy. In this field France built up a very considerable empire in north and west Africa. In 1894 she regained her position as a great power by forming a defensive alliance with Russia to counterbalance the Triple Alliance of Germany, Austria and Italy. When in 1904 and 1907 France and Russia settled their outstanding disputes with England this combination became known as the Triple Entente, a combination which alarmed the Central Powers because it seemed potentially stronger than

the Triple Alliance. Germany attempted to break up the entente by challenging French ambitions in Morocco, but her efforts only brought England and France closer together. Similarly Germany and Austria aimed to restore the balance of power by weakening Russia's position in the Balkans. When in 1914 Russia accepted their challenge the Central Powers precipitated a war which eventually became world-wide. See WORLD WAR.

A German invasion on a tremendous scale nearly captured Paris, but was checked at the Marne on Sept. 1914. For four years the northern departments of France were the scene of the most destructive warfare in history. Although English and American armies played their part the largest share of the fighting in this theater fell upon the French. When in 1918 defeat and revolution brought the Germans to terms the statesmen of the world gathered at Versailles to rearrange the map. By the peace treaties France regained Alsace-Lorraine and had her future security guaranteed by the disarmament of Germany and the demilitarization of the Rhineland. She became mandatory for Syria and for some of Germany's African colonies. A large share of the huge sums demanded of Germany as reparations for the war destruction was allotted to France; but the next decade was troubled by difficulties in collecting. In 1924 France seized the Ruhr to force Germany to admit this obligation. In the League of Nations France has a permanent seat on the Council. She has strengthened her position by political and military agreements with Belgium, Czechoslovakia, Poland, Rumania and Jugoslavia, so that she now exercises a hegemony in Europe. The fact that France is more nearly economically self-sufficient than other powers has enabled her to make a better recovery from the war, and this has helped to give her a financial leadership as well. Her political security is further increased by the Locarno agreements, 1925, whereby her northeastern frontier is guaranteed against German attack by both England and Italy, while she in turn with others guaranteed the existing German frontier on the west. It may be hoped that this will, in time, make possible Franco-German friendship and cooperation.

R. A. N.

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FRANCHISE, in law, a privilege of a public nature granted by government to an individual or corporation. A franchise may be given to, e.g., a bank or railway company, for a long or indefinite period of time, and may cover the right to secure possession of land under the doctrine of eminent domain. The term also covers the right to vote at elections.

FRANCIA, JOSÉ GASPAR RODRIGUEZ (1761-1840), Paraguay's first president and dictator, born of Brazilian parents. He was educated in law in

Cordoba, Argentina and established a reputation as a lawyer in Asuncion. In 1881 he became head of the Paraguayan junta. By imprisoning or exiling his opponents he cleared the stage for exercising undisputed sway. Until 1840 he ruled Paraguay with an iron hand, his policy being to keep Paraguay in complete isolation. He reorganized the finances, the army and the administration of justice, filling all the lower offices with his own followers. He introduced compulsory primary education and reduced the numbers and power of the clergy. The source of his power was the army. He maintained peace and the industry and agriculture of the country prospered to a certain degree. Though Francia was honest and economical with the public funds, he became more and more autocratic and feared as years went on.

FRANCIS I (1494-1547), King of France, son of Charles, Count of Angoulême, was born at Cognac, Sept. 12, 1494. In 1515 he succeeded his cousin Louis XII, whose daughter he had married, as king of France. In the first year of his reign he reconquered Milan. Later he was chiefly engaged in wars with Charles V who had become Holy Roman Emperor in 1519, and had allied himself with Henry VIII of England and the pope against France. In the battle of Pavia, 1525, Francis was taken prisoner, held for a year and made to relinquish Burgundy and his possessions in the Low Countries and Italy. Burgundy's loyalty and England's fear of the growing power of Charles V served to stem the tide and finally the peace of Crespy in 1544 brought an end to his wars with Charles. The French Renaissance flourished under Francis. He encouraged art and learning, invited painters and scholars to come to France and installed Benvenuto Cellini and Andrea del Sarto, among others, in his court. He founded libraries and schools and built or enlarged several of the most beautiful palaces in France. His name is specially associated with Fontainebleau. He died at Rambouillet, France, Mar. 31, 1547.

FRANCIS II (1544-60), King of France, was born at Fontainebleau, Jan. 19, 1544. He was the eldest son of Henry II and Catherine de Medici. In 1558 he married Mary, Queen of Scots, and the following year succeeded to the throne of France and ruled for one year. He was directly under the influence of his uncle Francis, the duc de Guise, and the Cardinal Charles of Lorraine, who controlled the government and who plunged the country into civil war. Francis died on Mar. 5, 1560.

FRANCIS, DAVID ROLAND (1850-1927), American public official, was born in Richmond, Ky., Oct. 1, 1850. He graduated from Washington University, St. Louis, in 1870, and after working as a clerk he established a grain and commission business in 1877. Entering politics in 1885 he became Mayor of St. Louis; four years afterwards he was elected Governor of Missouri and during Cleveland's second term he served as Secretary of the Interior, 1896-1897. In 1904 he was elected president of the Louisiana Purchase Exposition at St. Louis and in

1796 became Ambassador to Russia. He returned to St. Louis in 1918 where he died Jan. 15, 1927.

FRANCIS, SIR PHILIP (1740-1818), British political leader, was born in Dublin, Oct. 22, 1740. His public career began at 16 in the office of the secretary of state in London. He continued it as secretary of a mission to Portugal in 1760, secretary to the elder Pitt in 1761, and first clerk in the war office in 1762. In 1774 he went to India with the council of Bengal, and in 1784 became a Whig member of Parliament where he was prominent in effecting the impeachment of Warren Hastings, with whom he had formerly fought a duel. He is the reputed author of the "Junius Letters" published in 1769-72 in the *Public Advertiser*. He died in London, Dec. 23, 1818.

FRANCISCANS, members of the religious order of mendicant friars established by St. FRANCIS OF ASSISI in 1209. They are also known variously and widely as Barefooted Friars, Friars Minor or Minorites, Cordeliers and, in England, as Grey Friars. The order was confirmed by the Pope in 1210 and formally ratified in 1223. The gray habit of the Franciscans was of coarse cloth, a pointed hood or capuche and a girdle of rope. The rule of the Order calls for absolute poverty, obedience, celibacy and the living on alms. After the death of St. Francis, division arose regarding the interpretation of the vow to poverty, some of the members maintaining that while property was denied to the individual friar, the community of friars should be permitted to acquire such. The order is now established in three grades: male members bound by solemn vows, such as the CAPUCHINS; nuns religious; and the tertiaries, which includes in its membership lay persons and certain congregations affiliated with the order. This last grade also includes such groups as the Franciscan Brothers, who devote themselves to educational work. Prominent Franciscans have included Duns Scotus, Roger Bacon, Alexander of Hales and Occam, while Americans often recall that both Christopher Columbus and Queen Isabella of Spain were tertiaries.

FRANCIS FERDINAND (1863-1914), Archduke of Austria, was born on Dec. 18, 1863, at Graz. He was the nephew of Francis Joseph, the Emperor, and upon the death of the Crown Prince Rudolph in 1889 was the heir apparent to the Austro-Hungarian throne. In matters of state he believed that the maintenance of the Empire as a great power depended on the settlement of domestic affairs. He favored friendly relations with England, Germany and Russia, and believed that an eventual reckoning with Italy was inevitable. On June 28, 1914, he and his wife were shot by a young Bosnian of Serbian citizenship at Serajevo. This assassination, bringing to a climax the feeling of hostility between Austria-Hungary and Serbia, led directly to the Austro-Hungarian ultimatum to Serbia, and, hence, was an immediate cause of the WORLD WAR.

FRANCIS JOSEPH I (1830-1916), Emperor of Austria and King of Hungary, was born Aug. 18,

1830. He became Emperor at the age of 18, following the abdication of his uncle, Ferdinand, in 1848, after the revolutions in the different parts of the Empire in the spring and summer of that year. Not considering himself bound by the promises made by his predecessor, he abolished the constitution granted by Ferdinand and, with the aid of a Russian army, suppressed the revolution in Hungary where L. KOSUTH had proclaimed a republic in March, 1849. But the unity of the Austrian Empire could not be maintained continuously by military force. Its polyglot population gradually became race-conscious during the long reign of Francis Joseph, and his entire life was harassed by their incessant and ever increasing demands for autonomy or independence. One by one the different parts broke away until the final disintegration came in the World War.

In 1859 Lombardy was surrendered to Italy, and, as a result of the crushing defeat at the hands of Prussia in 1866, Venetia too had to be given up. At the same time, BISMARCK insisted on the withdrawal of Austria from German affairs and the severance of all political ties with the rest of Germany. Furthermore, the Emperor, weakened by the defeats and the loss of prestige, was forced to yield to the demands of the Hungarians for autonomy. Hungary was recognized as a separate kingdom on an equality with Austria and united with it through the person of the sovereign Francis Joseph, who was duly crowned King of Hungary.

As the reign progressed he also found it necessary to make concessions to democracy, and in 1861 he proclaimed a constitution in the Austrian Empire. Despite this, however, discontent among the non-German and non-Magyar populations of the Dual Monarchy continued to increase.

In 1908 Austria annexed the Slavic provinces of Bosnia and Herzegovina. This greatly angered Serbia and Russia, and added new fuel to the agitations against the Hapsburg rule both within the monarchy and without, finally leading to the assassination, in 1914, of the Archduke Franz Ferdinand, the nephew of the Emperor and heir to the throne. Apart from its tremendous international consequences, the assassination was the third of a series of domestic tragedies in the life of the ill-fated monarch. In 1889 Rudolf, his only son and heir, came to a mysterious death at his hunting lodge at Meyerlin and a few years later the Empress was assassinated in Switzerland. Francis Joseph I entered the World War a broken old man, and died on Nov. 21, 1916. W. E. LI.

FRANCIS OF ASSISI, ST. (c. 1182-1226), founder of the Franciscan Order (*see* FRANCISCANS), was born Giovanni Francesco Bernardone, at Assisi, of a wealthy family, about 1182. Gay and handsome in his youth, he was much esteemed by his wealthy young friends, but a serious illness turned his thoughts to ascetic devotions. At 28 years of age, choosing "a wife of surpassing fairness," Lady Poverty, he gave up all worldly goods, and induced some of his young friends to do the same, founding the *Frati Minori*,

variously called in Europe the Franciscans, Minorites, Barefooted Friars and Grey Friars. Their rule included vows of poverty, chastity, obedience, preaching and ministry to body and soul. Pope Honorius III ratified the rule in 1223. After two attempts to preach to the infidels in Syria and Morocco, Francis eventually visited Egypt in 1219, and preached before the sultan. On his return he retired as a hermit to Monte Alverno, where, it is said, he experienced the miracle of the *stigmata*. The wide and earnest preaching of his friars and the influence of his own life have given him fame throughout Christendom. His love for animals and birds, well illustrated in his *Song of the Creatures*, "the loveliest piece of religious poetry since the time of the Evangelists," as Renan writes, his inauguration of the Christmas celebration of devotion of the Crib, and the poetry of the legends concerning him, have combined to call forth the admiration of all religions. Many have held that the life and work of St. Francis started the artistic revival in Italy in the Middle Ages, Renan going so far as to declare "the beggar of Assisi was the father of Italian art." He was canonized by Gregory IX in 1228, two years after his death on Oct. 3, 1226. In 1902 there was organized at Assisi the International Society of Franciscan Studies, to collect a library on his fame, and help perpetuate his memory.

FRANCIS OF LORRAINE, DUKE OF GUISE (1519-63), was born at Bar on Feb. 17, 1519. At the siege of Boulogne in 1545 he received a wound which accounted for his nick-name *Balafré*. His service to France in her armies and his marital relations with the French kings brought him into great favor at court. His brother, the cardinal of Lorraine, at that time controlled the internal workings of the government, and the Guise family was the most powerful in France. With bloody executions Francis sternly repressed the conspiracy of Amboise, which intended to overthrow the Guise authority. He began a civil war against the Huguenots in 1562, and sacked Rouen, a Huguenot stronghold, in the same year, taking Condé, a Protestant leader, prisoner. In 1563 while with his army outside Orleans, he was shot by a Huguenot. He died on Feb. 24, 1563.

FRANCIS OF PAULA, ST. (1416-1507), founder of the ORDER OF MINIMS, was born at Paola, Calabria, Italy, in 1416. After living as a youth in the solitude of a cave for meditation, at 19 years of age he was joined by others, and in 1436 formed the order of the Hermits of Saint Francis. He later went to France and was greatly favored by Charles VIII, who built him a monastery at Plessis-lès-Tours, in order to consult him, for Francis was credited with many miracles and with the gift of being able to foretell the future. In 1474 Pope Sixtus IV appointed him superior-general of the Order of Minims, as the order was then called, which was confirmed by Alexander VI. He died at Plessis in Apr. 2, 1507, and was canonized by Leo X in 1519.

FRANCIS OF SALES, ST. (1567-1622), bishop of Geneva and one of the founders of the ORDER OF

THE VISITATION, was born in August, 1567, at the castle of Sales, near Annecy in Savoy. He was educated at the Jesuit College of Clermont at Paris, and at Padua, where he took his law degree. In the last decade of the 16th century he took an active part in helping the Duke of Savoy suppress Calvinism, so that by 1598 the country was again Catholic. In 1599 he was made coadjutor bishop and, in 1602, bishop of Geneva. He wrote among other works a *Traité de l'amour de Dieu*. He was canonized in 1665, having died at Lyons, Dec. 28, 1622. His day is commemorated on Jan. 29.

FRANCIS XAVIER. See XAVIER, FRANCIS.

FRANCK, CÉSAR AUGUST (1822-90), Belgian music composer, was born in Liège, Dec. 10, 1822. After studying at the Liège and Paris conservatories he engaged in teaching for several years, in 1848 becoming organist of Ste. Clotilde, Paris, where he remained for 32 years. Meanwhile, in 1872, he began teaching the organ at the Paris Conservatory, numbering among his pupils such musicians as D'INDY, Duparc, Pierne, and Benoit. His chief works are the Symphony in D minor, an oratorio *Les Béatitudes*, a violin sonata, and a prelude, chorale, and fugue for the piano. Protracted work at the organ colored his efforts as a symphonist, and an ecclesiastical air permeates his compositions. His best work breathes a purity and serenity that place him among the distinguished composers of the 19th century. He died at Paris, Nov. 8, 1890.

FRANCKE, KUNO (1855-1930), German-American philologist and literary historian, was born at Kiel, Sept. 27, 1855. From 1873 to 1878 he studied at Kiel, Berlin, Jena and Munich, receiving his doctorate from Munich in 1878. He was assistant editor of the *Monuments Germaniae Historica*. From 1884 to 1917 he taught at Harvard, where he became professor of history of German culture in 1896. His best known work is *Social Forces in German Literature*, 1896. Among his other writings were *Glimpses of Modern German Culture*, 1898, and a poem, *Deutsches Schicksal*, 1923. In 1902 he was instrumental in procuring for Harvard the Germanic Museum. He died at Cambridge, Mass., June 25, 1930.

FRANCO-GERMAN WAR (1870-71), a struggle between France and the German states, which resulted in the deposition of Napoleon III, the establishment of the Third Republic in France, and the formation of the German Empire. In the decade preceding the outbreak of hostilities political relations between France and Prussia had been severely strained by the boldness of Bismarck's foreign policy and by the erratic behavior of Napoleon III. The first pretext for war was seized by the French when the Spanish, after expelling Queen Isabella in 1868, offered the throne to Prince Leopold of Hohenzollern. The French demanded that William I declare formally that, in entertaining the offer, Germany had meant no offense to France and that Germany would never reconsider the proposal. William I brusquely refused to hear addi-

tional representations from the French envoy, and had telegraphed to Bismarck an account of what had happened with instructions to publish it if Bismarck saw fit. The minister did publish the account, but in a compressed form, including the essential facts. Napoleon III, interpreting the actions of William I and Bismarck as reflections on French honor, declared war on Prussia on July 19, 1870.

This move was militarily unwise, for Von Moltke, German chief-of-staff, had a well-trained army of 450,000 men with 400,000 reserves, while the French army of the Rhine numbered only 310,000 men. On Aug. 4 the French were defeated at Weissenburg; at Worth on Aug. 6 they were severely defeated again, and were forced to evacuate Alsace. Moltke rapidly moved against the main French army in front of Metz. By feinting a frontal attack he succeeded in a bold flank movement past the entire right of the enemy, intercepted the French lines of communication, and took up a position at Gravelotte. This forced Bazaine to bring his army west out of Metz to its defense. On Aug. 18 the French were defeated and driven back into Metz, where they were at once besieged. News of this defeat led Napoleon III and MacMahon, commander of the reserves at Nancy, to attempt the relief of Metz. Forced northward, they were hopelessly defeated Sept. 1 at Sedan, and the entire army of 83,000 men and the Emperor were captured. By Sept. 19 the Germans had besieged Paris. Metz capitulated on Oct. 27, and Paris on Jan. 28, 1871. Elections for a national assembly were held in February, and peace commissioners were appointed to negotiate the Peace of Frankfurt, signed on May 10. By the peace Germany obtained Alsace, one-fifth of Lorraine and an indemnity of \$1,000,000,000.

FRANCONIA, the name of a part of the lands used by the Franks in medieval Germany. Franconia was located in the valley of the Main and was bounded by the Rhine on the west, Bohemia on the east, Saxony and Thuringia on the north, and Swabia, old Bavaria, on the south. The territory was ruled by Clovis in the 5th century and by Charlemagne several centuries later. Conrad, duke of Franconia, became German king in 911. In the 10th century, the territory was divided into Eastern Franconia and Rhenish Franconia. Rhenish Franconia eventually disintegrated into a number of free towns, but Eastern Franconia retained a nominal independence under church control until the 19th century, when it became an integral part of Bavaria.

FRANCONIA NOTCH, a narrow defile in the White Mountains in New Hampshire. The notch has been cut by the Pemigewasset River and separates the Franconia and Pemigewasset ranges. The Great Stone Face, immortalized by Nathaniel Hawthorne in his story by that name, looks down on the Notch from the upper cliffs of Profile Mountain.

FRANCS-TIREURS (Sharp Shooters), originally French private rifle-shooting clubs, which afterwards engaged in active hostilities against the Germans in the Franco-Prussian War. They were not part of the

regular army, wore no uniform and generally undertook guerilla operations after the main body of enemy troops had passed. As a result the Germans usually considered them as armed non-combatants and shot them on capture. Not all the operations of the Franks-Tireurs, however, were conducted by stealth behind the enemy lines. At Châteaudun, Oct. 18, 1870, they joined the regular troops in its heroic defense.

FRANGIPANI (*Plumeria acuminata*), a handsome tree of the dogbane family known also as temple flower. It is a native of Mexico widely planted in warm regions for its very showy, exceedingly fragrant flowers, which bloom throughout the year. The frangipani is usually a small tree, sometimes 20 ft. high, with an abundant milky juice and thick branches bearing oblong, pointed leaves, often a foot in length, and large waxy, funnel-shaped flowers, whitish in color with a pale yellow center, produced in terminal clusters. In Mexico, where the tree is a favorite ornamental, the flowers are extensively used for decorations and the juice is sometimes employed medicinally.

FRANK, BRUNO (1887-), German author, was born at Stuttgart, June 13, 1887. He wrote some verse, but soon turned to writing theatrically effective dramas, dealing especially with modern psychology and the more advanced social problems. These included *Die Schwestern und der Fremde*, 1918, and *Das Weib auf dem Tiere*, 1921. He wrote numerous short stories, and his outstanding novels are perhaps *Die Furstin*, 1915, *Der Baron Trenck*, 1926, and the narrative *Tage des Konigs*, 1924. Among Frank's works that have been translated into English are *Trenck*, 1928, and *The Persians Are Coming*, 1929.

FRANK, GLENN (1887-), American educator and publicist, was born at Queen City, Mo., Oct. 1, 1887. He studied at Northwestern University and was assistant to the president there from 1912-16. The following three years he was associated with Edward A. Filene, Boston merchant, in research and organization, after which he joined the editorial staff of the *Century Magazine*. Frank became editor-in-chief in 1921 and attracted wide attention by publishing his advanced theories of education. In 1925 he was elected president of the University of Wisconsin. His books include *The Politics of Industry*, 1919, and *An American Looks at His World*, 1923.

FRANK, JACOB (1726-91), notorious anti-Talmudist, convert to Mohammedanism and Catholicism, and pseudo-Messiah, was born at Korolowka, Poland, in 1726. He was the founder of the so-called Frankist movement, a semi-Christian religious association which flourished among the Polish Jews in the latter half of the 18th century.

In his youth Frank entered into relations with the Sabbatians, the followers of Sabbatai Zevi, at Salonica, and later announced that he was the reincarnation of the Messiah, and the actual successor of Sabbatai Zevi himself. In this manner he gained the support of the Sabbatians of Poland. He also made the claim of being a miracle-worker and asserted that he was divine

in nature. His followers, the Frankists, had as their avowed task the undermining of rabbinical Judaism and the destruction of the Talmud. In its stead they revered the Zohar, which, they declared, contained Moses's true teachings. For this reason, as well as for their alleged unchaste and immoral acts, they were persecuted and bitterly opposed by the followers of rabbinical Judaism in Turkey and Poland; they were even excommunicated by the latter. A violent dispute arose between the followers of rabbinical Judaism and the Frankists which led to the holding of a religious disputation in 1757 at Kamieniec-Podolsk under Bishop Dembowski, and to persecutions of the Jews and to the burning of many copies of the Talmud. The Frankists, to gain the favor of the non-Jewish elements, falsely alleged that their Cabalistic trinity was like the trinity of the Catholic Church.

Many years of controversy, disputations and hostility followed, in the course of which the Frankists actually brought the absurd charge of ritual murder against the followers of rabbinical Judaism, declaring that it was contained in the Talmud. Finally, several thousands of the Frankists accepted baptism in Lemberg in 1759; Frank had himself baptized in Warsaw several months later. Only a short time after that, however, he was arrested and imprisoned as an impostor, false Christian and blasphemer of the Christian religion. He was finally released by the Russians. Subsequently he proclaimed his daughter Eva as the incarnate godhead, even as he himself was the Messiah and Lord incarnate. He continued his impostures in Moravia and Bohemia until his death at Offenbach, Germany, in 1791; here he had kept up his court and his mystical and Messianic pretenses to the very end.

Soon after his death the Frankist movement gradually dissolved, until only a few of his followers remained. Many Polish Jewish families still owe their descent to the Frankists; these families are to-day called Frenks or Shäbs (Sabbatians). A. SH.

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FRANK, WALDO DAVID (1889-), American author, was born at Long Branch, N.J., Aug. 25, 1889. He was educated at Yale. After working on various New York newspapers, he served as contributing editor on *The New Republic* and the *New Masses*, and as lecturer on modern art and literature at the New School for Social Research, New York City. Among his publications are *The Unwelcome Man*, 1917, *Our America*, *Time-Exposures*, *The Rediscovery of America*, 1928, and *America Hispana*, 1931.

FRANKEL, ZECHARIAH (1801-75), distinguished German rabbi, was born at Prague in 1801. He was instrumental in the creation of the so-called school of "historical Judaism" which endeavors to harmonize the rational interpretation of Judaism with fidelity to traditional beliefs and religious observances. In 1854 Frankel established in Breslau a seminary for

the training of modern conservative rabbis, the first of its kind. The Breslau Seminary was the first to require that its students combine in their studies both secular and religious subjects. Frankel's contributions to the study of the Greek Bible and to the literature of the Talmud were epoch-making. Under the influence of the *Monatschrift*, which he edited, Jewish learning assumed an occidental character. Frankel died in 1875.

FRANKENSTEIN "or The Modern Prometheus," an extravagant tale of horror by MARY WOLLSTONECRAFT SHELLEY; published 1818. This is the gruesome story of a Swiss student, Frankenstein, who, discovering a process for making life artificially, creates a monster, and is thereafter pursued by his creation through many lands until he has paid in full the penalty of his daring.

FRANKFORT, a city of north central Indiana and the county seat of Clinton Co., 40 mi. northwest of Indianapolis. It is served by five railroads. In addition to important repair shops of the Nickel Plate Railroad, the city has brass and iron works and other factories, and trades in farm products of the vicinity. In 1929 the manufactures reached approximately \$6,000,000; the retail trade amounted to \$6,862,354. Frankfort was founded in 1830 and incorporated 1875. Pop. 1920, 11,585; 1930, 12,196.

FRANKFORT, the capital of Kentucky, and the county seat of Franklin Co., situated on the Kentucky River, about 65 mi. east of Louisville. Three railroads, four Federal highways and traction and bus lines afford transportation. Frankfort is in a rich section which produces tobacco, corn, alfalfa and rye, and raises thoroughbred horses. The chief local manufactures are furniture, brooms, shoes, twine and shirts. In 1929 the retail trade amounted to \$5,564,877. The state industrial college for negroes, the state home for feeble-minded children, the state arsenal, the state government buildings and library and the state normal college are located here. The state historical society occupies the old state capitol, erected in 1830. Frankfort was founded by Gen. James Wilkinson in 1786. Franklin Cemetery contains the graves of Daniel Boone and many noted Kentuckians. Pop. 1920, 9,805; 1930, 11,626.

FRANKFORT-ON-MAIN, a Prussian city in the province of Hesse-Nassau, on the navigable Main about 20 mi. east of Weisbaden, between the two sections of Hesse. It lies in a rich plain and has a salubrious climate.

The oldest part, on the river, surrounds the cathedral and lies within the boundaries of former walls of the 12th century. Later fortifications included a larger area and have been transformed into parkways. A few gates and towers still remain. Adjoining the old city with its narrow streets are the newer sections, with the principal thoroughfares radiating to the periphery. Of the churches, the most noteworthy are the Gothic cathedral, founded in 870 and restored several times from 1562 to 1806, the coronation church of the German emperors; St. Leonard's Church;

Church of Our Lady; and the Church of the Teutonic Order. The most important secular buildings are the Römer, an impressive example of medieval architecture consisting of a combination of 12 buildings, including the large new rathaus; the Goethe house near by, where the poet was born and spent his youth; Thurn and Taxis Palace, and other imposing edifices.

Among the many modern structures are a stock exchange, an opera, a theater, a university and several government buildings.

Parkways surround the old city and spacious parks are scattered throughout the city and on the outskirts. Frankfort is the center of an industrial area whose chief manufactures are machines, metal, leather, chemical and electrochemical goods. Commerce, however, is more important than the industries. Besides the industrial output mentioned, the city trades in food products, lumber, skins and textiles. There are two international sample fairs annually, and there are cattle markets.

The city has a university, founded in 1912, a number of research foundations, 15 museums, six important libraries and three archives.

With the incorporation of 16 suburbs and villages in 1925, and of the cities, Höchst and Griesheim, in 1928, the population was 549,000.

FRANKFORT-ON-ODER, a German city located in Brandenburg, on the Oder River about 50 mi. east of Berlin. The old city is united to the three suburbs on the other side of the river by a long bridge. Notable among the buildings is St. Mary's Church of the 13th century. The city manufactures machines and tobacco products and has a heavy wine and lumber trade. It has a port on the Oder and a flying field. Frankfort was founded in 1253 by Franklin merchants and was a member of the Hanseatic League during the 14th and 15th centuries. For a time it was the seat of a university, the students of which included Ulrich von Huthen, Heinrich von Kleist and the Humboldt brothers. The city was besieged frequently during the many wars in its long history. Pop. 1925, 71,130.

FRANKFORT PARLIAMENT or NATIONAL ASSEMBLY, May 18, 1848-May 30, 1849, a national assembly of Germany, elected by the people during the enthusiasm for political reform in 1848. At the suggestion of a group of Liberals and Republicans who met in Heidelberg on Mar. 5, 1848, a preliminary Parliament met by invitation at Frankfort on Mar. 31 and, after some discussion, issued a request to all the German states to provide for the election of delegates to a representative German Parliament. The Diet of the Confederation, fearful of the revolutionary movement, gave its support and suggested elections on the basis of one deputy for every 50,000 of the population.

On May 18 about 600 delegates met at Frankfort to begin the difficult task of constitution making for a new Germany which was to replace the Confederation of 1815. Unfortunately, the deputies although

very able, lacked experience, and Von Gagern, the presiding officer, had great difficulty in directing its proceedings. Much time was wasted in futile discussions over fundamental rights before the really serious difficulties were attacked. These arose out of the question of how to secure sovereign powers for the central Government and how to deal with the Austrian problem. On the latter, the delegates divided. One group called the Small German Party wished to exclude Austria altogether as being predominantly foreign and non-German in her polyglot population; the other, called the Large German Party, demanded her inclusion. On the matter of securing adequate power for the central Government, the fears and jealousies of the princes and rulers were of course aroused from the first. It was of the utmost importance for the Parliament to act promptly while the enthusiasm of the revolution was still at its height. While they were still carrying on their discussions, however, the revolution in Vienna was overthrown, and Austria ordered the withdrawal of her delegation. In other parts of Germany the revolutionary ardor was cooling also.

Nevertheless, the Assembly continued its work, finally completing the constitution for an hereditary empire which excluded all non-German lands from the proposed German empire and provided a National Government. In Apr. 1849 it sent a delegation to Berlin to offer the title of hereditary German Emperor to the King of Prussia. Frederick William IV, fearful of involving himself in a war with Austria and the other states, took counsel and declined the proffered crown. His refusal was the death blow to the Parliament. It dwindled rapidly, most of the delegates returning home. A small group of irreconcilables, however, remained and voted to transfer the Parliament to Stuttgart, where it had its first session on June 6. Later in the month the place of meeting was closed by the military, and the Rump Parliament too came to an end.

The failure of the Frankfort Parliament was of serious import to the German people and to Europe because it marked the defeat of the struggle to unite Germany by Parliamentary and Constitutional Methods. When unification was finally achieved, it came through Prussian leadership and the wars associated with Bismarck's policy of "blood and iron."

W. E. L.

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FRANKINCENSE, a fragrant gum resin obtained from certain East Indian trees. It was much used for sacrificial purposes by the ancient Egyptians and by the Jews of Biblical times. There is frequent reference to the term in the Pentateuch and elsewhere in the Bible. In the Red Sea region frankincense is valued for its sweet odor when burned, and in ancient times and during the Middle Ages it was often recom-

mended as a medicinal agent for a great variety of ills. Commonly the term "frankincense" is to-day applied to a resin extracted from the Norwegian spruce fir and is used as one of the ingredients in certain ointments and liniments in commercial use.

FRANKING PRIVILEGE, the right to send letters and postal packages free of cost. In the United States the privilege is limited to national officers for official business, although a few private individuals have been granted the privilege by special congressional action.

FRANKLIN, BENJAMIN, American statesman, born on Milk Street, opposite Old South Church, Boston, Mass., Jan. 17, 1706, was the son of Josiah Franklin and his second wife, Abiah Folger, daughter of Peter Folger of Nantucket. Ben, said to have read the Bible at five and been able to write at seven, was his father's favorite and at first intended for the ministry as the tenth or tithe son, but was taken out of school after two years to assist his father in making candles and soap.

Disliking this, the boy was apprenticed at 13 to his half-brother, James, in the printing business, and made diligent use of such books as fell into his hands. To *The New England Courant*, started by James and other anti-Mather rebels in 1721, chiefly "to oppose the doubtful and dangerous practice of inoculating the small pox," Ben sent secretly in 1722 fourteen

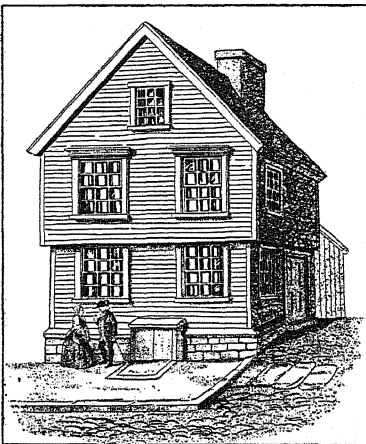
bullied and beaten by his elder brother and boss, he quietly, in Sept. 1723, slipped away to a sloop bound for New York. Not finding work there he hastened to Philadelphia, where he worked with Keimer, a silly, gluttonous French printer with a mania for religions, and lodged comfortably with the widow Read, whose charming daughter, Deborah, he married in 1730.

Encouraged by Sir William Keith, governor of Pennsylvania, Franklin went to London in the fall of 1724, to finish his education as a printer, learn the style of the day, and get the machinery and accessories for a printing shop. He found that Keith was unable or unwilling to help him financially, but he secured work at Palmer's famous printing house, where he wrote and printed a small pamphlet, *A Dissertation on Liberty and Necessity, Pleasure and Pain*, contending that there could be no such thing as religion. Later Franklin worked at Watts' Printing House.

After a year and a half in London, he was persuaded by a Quaker merchant, Denham, to return to Philadelphia and work for him, regretfully declining a tempting London offer to give swimming lessons. The death of Denham in an epidemic, which almost took Ben and left him with pleurisy, in Philadelphia in Oct. 1726, caused Franklin to accept large wages with Keimer. Discharged by Keimer, Ben and a fellow worker, Meredith, set up for themselves in 1728. In Mar. 1729, Franklin published a pamphlet favoring Pennsylvania paper money, which was issued; in September he bought from Keimer *The Pennsylvania Gazette*, a weekly newspaper, which he conducted until 1765.

In 1730 he bought out Meredith's interest, began to conduct the printing business alone and married Deborah Read, his first fiancée, now deserted by her first husband. The next year he established in Philadelphia one of the first circulating libraries in America, and in 1732 appeared the first of his *Poor Richard's Almanacks*, issued for the next 25 years and averaging more than 10,000 copies a year, exceeding the sale of any other colonial publication. In 1733 he acquired for business purposes an easy reading knowledge of French, Italian, Spanish and Latin. He organized a club of artisans, upper clerks, small tradesmen for mutual aid and protection, maintaining public rights, study of books, current events and business. A social club, study circle and moral organization combined, "The Junto," as they called themselves, "The Leather Apron Club," as they were nicknamed by the rich "Every Night Club," limited its members to those having no enemy in the club, loving humanity as a whole without distinction of religion, believing in freedom of conscience and loving and seeking liberty for its own sake. The founder dreamed of this as the beginning of a world-wide organization to promote virtue, liberty and knowledge.

Meanwhile, Franklin was rapidly making political and business friends. In 1736 he was chosen clerk of the general assembly and served in this educating

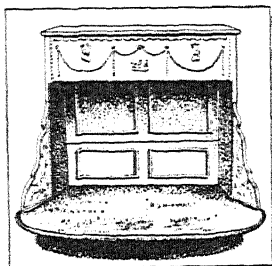


COURTESY METROPOLITAN MUSEUM OF ART
BIRTHPLACE OF BENJAMIN FRANKLIN
IN MILK STREET, BOSTON

letters signed "Silence Dogood," supposed to be by a widow of a country parson and ridiculing Mather as "Garrulous Dogood." When James was jailed for printing alleged impertinence to the government, Ben carried on the store, the printing shop and the newspaper as usual until James apologized and was released. Informed of the authorship, James was jealous and stopped the letters, but, forbidden to publish the paper, he had to tear up the apprenticeship paper and publish the *Courant* in Ben's name.

James's opinions and wordy quarrels seemed to Ben hardly worth fighting for, and, tired of being

and business-bringing job until 1751, when he became ineligible by being elected a member of the assembly, where he served for 13 years. In 1737 he was made postmaster of Philadelphia and about this time started a campaign to make the city a better place to live in, by organizing the first police force and fire company in the Colonies; by forming in 1749 with 23 others an educational association to carry out the ideas in his "Proposals Relating to the Education of Young in



COURTESY M. M. OF ART

THE "PENNSYLVANIA FIRE-PLACE" OR STOVE, DEVISED BY FRANKLIN ABOUT 1742

Pensylvania," opening in 1751 and getting a charter in 1753 for an academy, later the University of Pennsylvania; by helping found the American Philosophical Society in 1743; by organizing a militia force, improving the street lighting, assisting in founding a city hospital, and causing the paving of streets.

The Junto in general and especially Franklin won the favor of the educated and powerful men of Philadelphia and wide notice throughout the Colonies, and in England by sponsoring in 1730 the Library Company of Philadelphia and thereby setting up the first public library in the Colonies with a librarian. This project enriched Franklin's culture, opened distinguished homes to him, spread his ideas and his fame, increased the circulation of his newspaper. In 1731 he joined the Masonic Lodge of Philadelphia (founded four years previously) and thus acquired another link to upper society while the Junto kept him the leader of the lower middle class. He added to his printing shop the first stationery and book shop south of Boston, printed all kinds of books and pamphlets brought to him, spent much time on his cherished newspaper, his stage for playing his many parts as an actor, but made his more substantial profits from almanacs, printing for the proprietors and for the assemblies of Pennsylvania, New Jersey and Delaware.

Before his thirtieth year, Franklin had become a pioneer merchant, a master printer widely known, a leader in educational, intellectual, literary, municipal, colonial and intercolonial affairs. Through his great character, "Poor Richard Saunders," Franklin was so effectively preaching his ideals of bourgeois prudence, peasant wisdom and individual and social morality that he was already preparing the world to endow him with those qualities advocated and described by him.

Franklin's only legitimate son, Francis Folger, died in the smallpox epidemic in 1737 at the age of five. The grief-stricken father assured the public that the child had not been inoculated or vaccinated but had died from smallpox and went on his way trying to help out the city in its distress and panic. He became postmaster of Philadelphia and thus began his work as the father of the U.S. Post Office.

When Whitefield began to preach in Philadelphia in Nov. 1739, Franklin became his temporal manager and supported him loyally in his later visits of 1740, 1745-46-47, and in his traveling and preaching throughout the Colonies. Thus, in spite of his own placid life, Franklin seems to have sympathized with tendencies and results of the waves of religious enthusiasm brought on by the evangelists. This, too, though he had earlier left the Presbyterian Church for the Church of England. He took little part in the dispute between the war party of the proprietors and the king, and the peace party of Quakers and their allies but strove to build up agencies and sentiments of union throughout Pennsylvania and the other Colonies. In 1743, he joined the most intelligent men in his Junto, in his other organizations, in Philadelphia and available and interested distinguished men throughout Pennsylvania and the other Colonies to found the American Philosophical Society, open to all the learned men in the English Colonies and designed to encourage and promote the sciences, scientific work and useful discoveries.

When the city and the colony were in danger from the French invasions of the Delaware, Franklin issued in Dec. 1747, a pamphlet, *Plain Truth; or Serious Conversations on the Present States of the City of Philadelphia and Province of Pennsylvania. By a Tradesman of Philadelphia*. He took the lead in uniting and organizing all reconcilable elements for defence and, refusing to be colonel, served as a private in the defence regiment. This Pennsylvania association was the forerunner of Franklin's plan for intercolonial union offered to the Albany Congress.

Becoming interested in electricity in 1746, Franklin soon showed by his kite the identity of lightning and electricity and published in 1753 directions for protecting houses with lightning rods, his invention. He retired from his shop, leaving the business to his partner to manage, took a quiet home in which to carry on his study, writing and experimenting, and was elected member of the municipal council of Philadelphia. Louis XV wrote congratulating him, and the Royal Society of London gave him the Copley medal in 1753. Harvard, Yale and William and Mary colleges gave him degrees of Master of Arts.

With his business enterprises prospering in other Colonies and in the West Indies, Franklin was named one of the two officials in charge of the postal system of all the Colonies, and he made it efficient and financially successful by visiting almost every post office and constantly watching the whole system. He was removed in 1774 for his part in the Hutchinson letter publication. His plan of union presented to the Albany Congress (1754) was rejected by the Colonies because it gave too much power to England and by the mother country because it gave the Colonies too much self-government.

Franklin pledged his personal credit for the horses and wagons for Braddock's expedition and went to England in 1757 as agent of the assembly to appeal to the king when the proprietors persistently refused

to contribute taxes for defence. He contended then that the king could not make laws for the Colonies without the consent of their assemblies, but arranged a compromise with the proprietors and remained five years in England on this first foreign mission. During this time, he received degrees of LL.D. from the University of St. Andrews and D.C.L. from Oxford, wrote two pamphlets in 1760 favoring vigorous prosecution of the war until France should be driven out of Canada. He went home in 1762, but returned to England as special agent of the new assembly.

Opposing the Stamp Act as "the mother of mischief," Franklin presented with extraordinary ability the cause of the Colonies when he was questioned in committee of the whole House of Commons in 1766. His patient and intelligent efforts to interpret the Colonies and the home government to each other continued through the long weary years of misunderstanding, and New Jersey, Georgia and Massachusetts made him their agent. He was even powerful enough to cause the substitution of Lord Dartmouth for Lord Hillsborough as secretary for the Colonies, but, considering his usefulness at an end after his arraignment before the Privy Council for the publication of the Hutchinson letters, he set his affairs in order, turned over his agencies to Arthur Lee and left for Philadelphia Mar. 21, 1775. Elected a delegate to the Continental Congress the day after his arrival from England, he served on many committees and became the first postmaster-general in 1776, but relinquished the job to his deputy, Richard Bache (husband of his only daughter Sarah) after one year. As one of a committee of five to correspond with friends of the Colonies, he planned the appeal to the king of France and wrote Silas Deane's instructions. In spite of his 70 years, he went in Apr. 1776, to Montreal with others and tried unsuccessfully to win over the Canadians. As member of the committee for the Declaration of Independence, he suggested a few verbal changes. July 16 to Sept. 28, 1776 he presided over the Constitutional Convention of Pennsylvania, and immediately thereafter, with Adams and Rutledge, met his old friend Admiral Howe in the fruitless discussion of Howe's peace terms. Sent as commissioner to France with Deane and Arthur Lee, he collected all his available cash, between £3,000 and £4,000, lent it to Congress, and went to Paris. Franklin's popularity and prestige enabled him to secure much secret aid from France, and, after Burgoyne's surrender, a treaty of alliance in Feb. 1778. As sole plenipotentiary from Oct. 1778, he had the difficult task of persuading France practically to finance the conduct of the war, and collected enough to make all French loans and gifts total about \$60,000,000, an amazing sum for those days.

After helping Jay and Adams negotiate a treaty of peace with Great Britain, finally signed Sept. 1783, Franklin was relieved by Congress as he had long requested, and left Paris in July 1785. Jefferson said "No one can replace him, sir; I am only his successor." Arriving in Philadelphia in Sept. 1785, Franklin was

immediately made chairman of its council and soon chosen president of the supreme executive council (chief executive officer) of Pennsylvania and reelected in 1786 and 1787. As member of the Federal Constitutional Convention of 1787, he served as chairman in Washington's absence and favored a compromise between the plans for a highly centralized national government and a loose confederation of states. His influence was one of the greatest factors in securing ratification by Pennsylvania. Retiring in 1788, he lived in peace and quiet until his death Apr. 17, 1790. Earlier in that same year, he had, as president of the Pennsylvania Society for the Abolition of Slavery, signed a petition to Congress for immediate abolition. He was buried by his wife in Christ Church Cemetery, Fifth and Arch Streets, Philadelphia.

The son of the tallow-chandler had become one of the most prominent scholars of his century, the most versatile American of his age. E. J. W.

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FRANKLIN, SIR JOHN (1786-1847), Arctic explorer, born at Spilsby Apr. 16, 1786. He accompanied Flinders on an exploration expedition along the coast of Australia, took part in several other expeditions, explored the continental coast of North America and was made a knight upon his return to England in 1829. In 1844, he accepted the command of the expedition planned by the Admiralty to seek the northwest passage. His vessels were lost, being seen last in Baffin Bay, July 26, 1845. In 1859, Lady Jane Franklin sent out an expedition under Captain McClintock, who discovered that Franklin had died on King William's Land, June 11, 1847, and that he had found the Northwest passage before his death.

FRANKLIN, a city in central Indiana, the county seat of Johnson Co., situated about 20 mi. south of Indianapolis. Bus lines and two railroads afford transportation. Franklin College, founded in 1834, is located here. The city has furniture and Ford products factories. The chief crops of the district are corn, wheat and hay. Franklin was incorporated as a town in 1832 and as a city in 1850. The Indiana Masonic Home is in Franklin. Pop. 1920, 4,909; 1930, 5,682.

FRANKLIN, a town of southeastern Massachusetts, in Norfolk Co., situated on the New York, New Haven and Hartford railroad about 25 mi. southwest of Boston. It manufactures woolen goods, printing presses, felt and castings. Franklin is the seat of Dean Academy. It is the birthplace of HORACE MANN, the noted educator. Pop. 1920, 6,497; 1930, 7,028.

FRANKLIN, a city in southern central New Hampshire, in Merrimack Co., and situated on the Merrimack River, 19 mi. northwest of Concord. The Boston and Maine Railroad affords transportation. The river supplies hydroelectric power for the local factories, which produce chiefly woollens, hosiery, paper and machinery. The region is devoted to dairying,

truck farming and poultry-raising, and also has considerable stands of soft and hard wood timber. There are granite, garnet and mica quarries. Franklin is the birthplace of Daniel Webster. Pop. 1920, 6,318; 1930, 6,576.

FRANKLIN, an industrial city and county seat of Venango Co., northwestern Pennsylvania, situated at the junction of the Allegheny River and French Creek, 85 mi. north of Pittsburgh. It is served by motor buses and four railroads. The region has good farming country and highly productive natural gas and oil fields. Franklin has large oil-refineries, and industrial plants turning out oil well machinery, and supplies, petroleum products and steel products. The industrial output in 1927 was valued at \$35,600,000. In 1929 the factory output was valued approximately at \$28,000,000; the retail business amounted to \$8,030,154. Until 1735 there was an Indian village on this site. The city is on the site also of a citadel called Fort Venango. Franklin, named for Benjamin Franklin, was incorporated as a borough in 1823 and became a city in 1868. Pop. 1920, 9,970; 1930, 10,254.

FRANKLIN, BATTLE OF, Nov. 30, 1864, an engagement of the CIVIL WAR which resulted in defeat for the Confederate army. After the abandonment of Atlanta, the Confederate army was reorganized at Lovejoy's Station, Ga. Hoping to draw the Federal army out of Georgia, Gen. Hood marched into Tennessee with 44,000 men in three corps, under Generals Stewart, S. D. Lee and Cheatham, besides Forrest's cavalry command of 10,000. Gen. Sherman, however, abandoned the pursuit when he became assured of Hood's intentions, and began his "march to the sea," leaving Gen. Thomas with an army of about 40,000 Federal troops to cope with Hood. Thomas assigned his only two well-drilled corps to Gen. Schofield, with orders to impede the Confederate advance toward Nashville, retiring only as he was forced. Schofield's greatly inferior force neatly turned the Confederate charge at Spring Hill, near the Tennessee line, on Nov. 21, and passed safely northward. Hood, chagrined, made a desperate attack at Franklin, Tenn., on Nov. 30, making use of 27,000 men. Schofield at the time had approximately the same number. After a desperate engagement the Confederate army was completely repulsed. The Union loss was about 2,000; Confederate casualties were about 7,000, including 12 officers of the rank of general.

FRANKLIN, STATE OF, a self-constituted state in the Tennessee valley, ultimately a part of the State of Tennessee. Resenting the failure of North Carolina to protect the border settlements from Indian forays and to extend the machinery of civil and criminal law commensurately with the growth of settlement, delegates from each militia company of the three counties of North Carolina lying west of the Appalachian Divide resolved, on Aug. 23, 1784, that the region assume an independent status, and attempt to secure recognition from Congress as a separate state.

In December the State of Franklin, so named in hope that Benjamin Franklin would be induced to advocate their cause, was organized by an assembly of delegates, with a constitution modeled in its preamble after the Declaration of Independence and in its essential provisions after the Constitution of North Carolina. The first legislature met at Jonesborough in March 1785; John Sevier was elected governor.

In November 1785 the provisional constitution of Franklin was made permanent, after a stormy convention which served to unite the malcontents. The State of North Carolina continued to attempt to exercise jurisdiction; 1786-87 was characterized by brawls between rival sets of officials. In 1788 the dissension became open warfare. An army of frontiersmen led by Sevier marched against the force led by Col. John Tipton, most prominent enemy of Sevier and the State of Franklin, and engaged in a half-hearted skirmish. The frontiersmen were diverted by an Indian war, which they waged successfully. By 1789 the State of Franklin had dissolved.

FRANKLIN AND MARSHALL COLLEGE, an institution for men at Lancaster, Pa., chartered in 1787, was formed by a union of Franklin College, Lancaster County, and Marshall College of Mercersburg, Pa. It was established especially to minister to the educational needs of the German population of Pennsylvania. The college is under the general control of the Reformed Church in the United States. It had productive funds of \$1,035,184 in 1931. The library contains 57,000 volumes. In 1931-32 there were 710 students, and a faculty of 45 headed by Pres. Henry H. Apple.

FRANKLINIA (*Gordonia alataamaha*), a handsome small tree of the tea family, native to Georgia but now known only in cultivation. It grows 15 to 20 ft. high, with smooth, thin bark, dark red-brown branchlets and sparingly toothed leaves, lustrous above but pale below, which turn scarlet in autumn. The delicate white flowers, 3 in. or more across, appearing in September, are borne singly in the axils of the leaves.

FRANKLINITE, an iron black Ore of zinc. It occurs massive, and coarse to fine granular, sometimes in octahedral crystals. At Franklin Furnace, N.J., after which the mineral is named, it is found in limestone near its contact with granite. Franklinite is an oxide of zinc, iron and manganese, crystallizing in the ISOMETRIC SYSTEM. An inferior grade of dark paint is made of the ground mineral. *See also* ORE DEPOSIT; MINERALOGY.

FRANKS, the only Germanic people to establish what may in any sense be called a permanent state. They were divided into two main groups: the Salians, near the Scheldt; and the Ripuarians, who dwelt along the banks of the Rhine. Their numerous kings all claimed descent from a legendary King Merovech; hence the name Merovingian. About the middle of the 4th century the Salian Franks began to drift westward. Unlike other Germanic tribes they did not migrate far from their place of origin,

but expanded slowly without losing contact with Germany. Their career of conquest begins with the accession of Clovis in 481 as King of a portion of the Salians. By a series of successful wars he pushed the boundaries of Frankland southward substantially to the Pyrenees and eastward across the Rhine. His conversion to orthodox Christianity established cordial relations between the Franks and the Church.

Succeeding reigns extended Frankish territory in the Rhone valley and eastward to Central Germany. In the middle of the 8th century the Merovingian line of kings gave way to the Carolingians, the greatest of whom was CHARLEMAGNE, 768-814. Under him Frankland reached its widest extent. In the northeast the Saxons were defeated and the boundary pushed to the Elbe River; Bavaria was fully incorporated in the Frankish state; in Italy Lombard rule was blotted out and nearly the whole of the peninsula annexed; the Pyrenees were crossed, and the Spanish March established north of the Ebro in the Spanish Peninsula. The following generation saw Frankland divided into East and West Francia, and the Franks lost their identity in the mingling of German and Gallo-Roman blood. But the name lived on in popular usage. As late as the 12th century it was employed by Moslems in the East as a general designation for all crusaders to the Holy Land.

FRANTIŠKOVY LÁZNĚ. See FRANZENSBAD.

FRANZ, ROBERT (1815-92), German music composer, was born at Halle, June 28, 1815. He lectured at Halle University and conducted the Singakademie before deafness compelled him to retire in 1868. His compositions include a small number of choral works, but his chief contribution was in the field of lieder which he enriched by about 300 songs, many of them comparing favorably with those of SCHUBERT and SCHUMANN. His remarkable melodic gift made him one of the great song composers of the romantic period in GERMAN MUSIC. He died at Halle, Oct. 24, 1892.

FRANZENSBAD (Czech *Františkovy Lázně*), a Czechoslovak city and famous spa among the foothills of the Bohemian Forest about 5 mi. north of Cheb. It has Catholic, Protestant and Russian churches, a synagogue, casino, fine colonnades, four excellently equipped bathing establishments and a bath-hospital. It has a mild mountain climate, the air being fresh and pure, but not too dry. The temperature of the water from the many springs is constant and the taste is refreshing. Visitors annually average 15,000. The population is German. Pop. 1930, about 3,200.

FRASCH, HERMAN (1852-1914), American inventor, was born at Gaildorf, Germany, in 1852. He came to the United States in 1868 and entered the laboratory of pharmacy of Philadelphia College. In 1874 he established a laboratory of his own, studying to improve the production of commercial chemicals. In 1885 he turned to problems of the petroleum industry and patented many processes improving oil production and refining. In 1890 he discovered the Frasch method of sulphur mining by superheated

water which made it practicable to extract the theretofore useless sulphur from the deep Louisiana deposits. He died, May 1, 1914.

FRASCH PROCESS, a special method employed in mining SULPHUR. A hole is bored to the deposit and a six-inch, a three-inch and a one-inch pipe, one inside another, are driven to the bottom of it. Superheated water is pumped down the annular space between the six-inch and the three-inch pipes, and melts the sulphur. An air-lift pump acting through the one-inch pipe then forces the molten sulphur through the annular space between the one-inch and the three-inch pipes, to the surface, where it is allowed to solidify. See also DRILLING.

FRASER, CHARLES (1782-1860), American miniaturist, was born at Charleston, S.C., Aug. 20, 1782. His portraits include many of the notable Charlestonians and Southerners of his time. One of his best works, the miniature of Lafayette, executed upon the latter's visit to Charleston in 1825, is in the possession of the city; that of Lafayette's friend, Francis Kinlock Huger, was presented by the city to their illustrious guest. In 1854 Fraser published *Reminiscences of Charleston*. He died at Charleston, Oct. 5, 1860.

FRASER, JAMES EARLE (1876-), American sculptor, was born at Winona, Minn., Nov. 4, 1876. He studied at the Art Institute, Chicago, and with AUGUSTUS SAINT-GAUDENS. His works include the recumbent figure of Bishop Potter in the Cathedral of St. John the Divine, New York; the John Hay Memorial, Cleveland; the *Journey through Life*, in the Rock Creek Cemetery, Washington; the heroic sized statue of Alexander Hamilton, in the Treasury Building, Washington, and the *End of the Trail*, San Francisco. Fraser's interest in the American Indian is also evinced in the design of the 1919 nickel, which bears an Indian head upon the reverse and a buffalo on the obverse.

FRASER RIVER, the chief river of British Columbia, formed high in the Rocky Mountains by glacial streams. Starting in eastern Columbia, it follows the Cariboo Mountains in a northwestern direction for about 160 mi.; it then flows south almost to the United States border, then west into the Strait of Georgia. It is about 740 mi. long and drains 91,700 sq. mi.

From its source the river is loaded with débris from glaciers and this load combined with its swift current has cut the bed of the river gradually deeper, forming a canyon from 3,000 to 4,000 ft. in depth. In its lower course between Lytton and Yale the river flows through the gorge of the Fraser, providing some of the most magnificent scenery on the continent. It receives several large tributaries including the Quesnel, Chilcotin and Thompson, all of the same general character as the trunk stream. Yale, about 100 mi. from the mouth, is the head of steamboat navigation but canoes proceed as far as Tête Jaune Cache. Here, in the great bend of the river around the Cariboo Mountains, are extensive gold deposits.

The Fraser has some millions of latent horse power mostly undeveloped. It is important chiefly for fishing and lumbering. Great numbers of salmon are caught in its lower course and there are large canneries on its banks. Its mouth is becoming increasingly important as a port for ocean shipping.

FRASERVILLE. See RIVIERE DU LOUP.

FRATERNITIES, COLLEGE, organizations of college men and women, generally secret in character, and either honorary, professional or social in nature. The fraternity name usually consists of two or three Greek letters which commonly represent the organization's aims and purposes.

The college fraternity "system" dates back to the founding of Phi Beta Kappa in 1776. This fraternity, founded originally for social and literary purposes, soon became a purely honorary society and has retained that status to the present. No other permanent societies were formed until 1825 when Kappa Alpha was organized at Union College. In 1827, Sigma Phi and Delta Phi were formed at Union, these three fraternities being known as the "Union Triad" upon which the later social fraternity system is based. These fraternities expanded into other colleges and new organizations began. Before 1900, the following additional social fraternities had been founded: Alpha Delta Phi, 1832; Psi Upsilon, 1833; Delta Upsilon, 1834; Beta Theta Pi, 1839; Chi Psi, 1841; Delta Kappa Epsilon, 1844; Zeta Psi, Delta Psi and Theta Delta Chi, 1847; Phi Gamma Delta and Phi Delta Theta, 1848; Phi Kappa Sigma, 1850; Phi Kappa Psi, 1852; Chi Phi, 1854; Sigma Chi, 1855; Sigma Alpha Epsilon, 1856; Delta Tau Delta, 1859; Theta Xi, 1864; Alpha Tau Omega and Kappa Alpha (Southern), 1865; Pi Kappa Alpha, 1868; Sigma Nu and Kappa Sigma, 1869; Phi Sigma Kappa, 1873; Phi Kappa, 1889; Delta Chi, 1890; Alpha Chi Rho and Pi Lambda Phi, 1895; Delta Sigma Phi, 1899.

Sororities, women's organizations patterned after men's fraternities, may be said to have originated in 1870 with the founding of Kappa Alpha Theta, although this was preceded by earlier non-Greek letter organizations. Kappa Kappa Gamma was established later in 1870. Other sororities having their origin before 1900 are: Delta Gamma and Alpha Phi, 1872; Gamma Phi Beta and Sigma Kappa, 1874; Alpha Chi Omega, 1885; Delta Delta Delta, Pi Beta Phi and Beta Sigma Omicron, 1888; Alpha Xi Delta, 1893; Chi Omega, 1895; Kappa Delta and Alpha Omicron Pi, 1897; Zeta Tau Alpha, 1898.

Many additional fraternities and sororities have been founded since 1900 and some of them have grown into large and strong organizations. Most of the older and stronger organizations have many chapters throughout the United States; only a few fraternities have established chapters in Canadian universities.

Social fraternities are banded together in the National Interfraternity Conference; sororities in the National Panhellenic Conference. These organizations have done much to solve general fraternity problems

and particularly to remove the causes of much criticism of fraternities.

The development of most of the professional and honorary societies began later than that of the social fraternities, although Phi Beta Kappa, the oldest honorary society, antedates any of the social Greek-letter groups. Both professional and honorary fraternities are difficult to classify as many organizations have some elements of both types. Among the more commonly accepted honorary fraternities (in the order of founding) are: Phi Beta Kappa, general scholastic, 1776; Tau Beta Pi, engineering, 1885; Sigma Xi, scientific, 1886; Phi Kappa Phi, general scholastic, 1898; Phi Lambda Upsilon, chemical, 1899; Order of the Coif, legal, 1902, Alpha Omega Alpha, medical, 1902; Eta Kappa Nu, electrical engineering, 1904; Sigma Tau, engineering, 1904.

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FRATICELLI, a term of somewhat loose application, used in Italy during the 14th and 15th centuries to designate all mendicant friars, although the Latin verbal equivalent, *Frates Minores*, is restricted to Franciscans. Historically the name is limited to three groups of heretics having their origin in the branch of the Franciscan Order known as *Spirituals* or *Zelanti*, zealous interpreters of the Rule of St. Francis. There were three main divisions. 1, Adherents of Fra Angelo da Clareno, survivors of the suppression of the Franciscan Celestines, who claimed to be the true Order of St. Francis and refused to acknowledge John XXII as pope. They were numerous in central and southern Italy but after their leader's death (1337), broke up into divergent groups. 2, The Spirituals of Tuscany (c. 1309-31) who left their monasteries in 1312 as a protest against their superiors, the *Relaxati* (Conventuals). They took refuge in Sicily under Fra Enrico da Ceva and were excommunicated and banished by John XXII in 1318, but continued in Naples. They finally became associated with, 3, the Michaelites, followers of Michael of Cesena (Conventual General of the Minorites, 1316-28) and formerly *Relaxati*, who turned against Pope John XXII when his Bull "Ad conditorem canonum" (Dec. 8, 1322) threatened the order's basic principle of poverty. The deposed General and 50 Michaelites were protected by King Robert in Naples but later returned to their superiors. The Fraticelli prospered, however, in various districts until the appointment in 1426 by Martin V of St. John Capistran to take measures against them. Thereafter they gradually disappeared, the last recorded date of their activities being 1471.

FRAUD, a legal term used to cover all the situations in which one person succeeds in overcoming another through deceit. Fraud usually involves an intentional misrepresentation of facts that has been believed by the person to whom the misrepresentation is made, but if one by careless or negligent action causes another to believe certain fallacies, he may also be guilty of fraud. When one is induced

by fraud to enter a contract, he may rescind his agreement and recover the value given, or recover damages. But if goods sold under a fraudulent agreement are resold to an innocent party, the defrauded person cannot recover them.

Fraudulent Conveyance is a transfer of title of goods or land by the owner to another person for the purpose of deceiving a third party. When such a transfer is made in fraud of creditors, they may have the transfer rescinded. F. K. B.

FRAUNHOFER, JOSEPH VON (1787-1826), German optician and physicist, was born at Straubing, March 6, 1787. From 1807 he worked at perfecting the telescope lens and, while attempting to discover the coefficient of refraction of glass for lenses, he discovered the dark lines in the solar spectrum, now known as Fraunhofer's Lines. (*See SPECTRUM.*) Aside from the enormous importance of the accidental discovery, he likewise found the refraction coefficient he had sought, permitting a great improvement in lenses. He likewise developed the double-image micrometer which enabled accurate measurements to be made of the diameters, densities and distances of the sun and the planets. He died at Munich, June 7, 1826.

FRAUNHOFER LINES, dark lines in the spectrum of the sun, first described by the German physicist Fraunhofer. *See SOLAR SPECTRUM.*

FRAZER, SIR JAMES GEORGE (1854-), British anthropologist, was born at Glasgow, Jan. 1, 1854. He was educated at Cambridge. In 1890 he published *The Golden Bough*, the work by which he is best known, an investigation in twelve volumes into ancient beliefs, traditions, cults and folklore. He has also written a large number of books on various aspects of anthropology. He was knighted in 1914 and in 1925 received the Order of Merit.

FREDERICK I (c. 1123-90), or Frederick Barbarossa, German King and Holy Roman Emperor, the son of Frederick II, Duke of Swabia, was born about 1123. When his uncle, Conrad III, died in 1152, Frederick was elected King of Germany and showed immediately that he intended to take his royal and imperial mission very seriously. He dreamed of making the theory of the Holy Roman Empire a reality, and set himself energetically to the execution of the task. He found himself, however, confronted with the familiar difficulties. The popes refused to yield an iota of their claims in the matter of rival papal and imperial prerogative; the powerful German vassals were in a state of constant unrest; the Lombard cities resisted his attempt to assert effective rule in northern Italy.

In 1154 Frederick led the first of six expeditions to Italy. He sought to pacify the warring Italian towns, freed the papacy and Rome from republican experiment by executing Arnold of Brescia, and was crowned by Hadrian IV. He returned again in 1158, subdued rebellious Milan, and summoned a Diet at Roncaglia in 1159 to determine his rights as Emperor. The decisions of this body meant loss of in-

dependence for the Lombard towns and submission to the hated revenue producing governors imposed upon them. After the cruel destruction of Crema and Milan for non-submission to the Emperor, the Lombard League was secretly formed. Its forces administered a crushing defeat to Frederick at Legnano in 1176. The Peace of Constance in 1183 recognized the practical independence of the Lombard towns, and Frederick was forced to make humiliating terms with the pope. Frederick's troubles were not over, for when he returned to Germany he found the Guelph leader, HENRY THE LION, Duke of Saxony and Bavaria, up in arms against him. Frederick determined to punish Henry for his refusal to offer his feudal services in the Italian campaigns. Frederick was more fortunate in this contest with Henry, and, after defeating him, split up the duchy of Saxony. Frederick presumed in this fashion to rid himself of his more powerful vassals. It is interesting to note that both in Italy and in Germany his policy was such as to result in the growing influence and power of the cities; for although this growth took place against his will in Italy, in Germany Frederick deliberately pitted the power of the cities against the power of the rebellious vassals. After crowning his son Henry VI, King of Italy, Frederick lost his life on a crusading expedition, June 10, 1190.

FREDERICK III (1831-88), German emperor and king of Prussia, was born at Potsdam on Oct. 18, 1831. He received a careful education and was tutored in military studies by Moltke. In 1858 he married Victoria, the oldest daughter of Queen Victoria. During the reign of his father William I, he disapproved of the policies of Prussia under the chancellorship of Bismarck. In the Franco-Prussian War his troops were victorious at Worth and participated in the battle of Sedan and the siege of Paris. In his palace at Berlin centered the very best in literary and artistic society. He ascended the throne on the death of his father on Mar. 9, 1888, but attacked by cancer of the throat, he reigned only 99 days, dying on June 15, 1888.

FREDERICK, name of eight Danish kings, the first three being also kings of Norway. Frederick I (1471-1533) furthered the Reformation and the extension of trade. Frederick II (1534-88) fought Sweden without result, but furthered commerce, agriculture and science, particularly astronomy, materially assisting Tycho Brahe. Frederick III (1609-70) lost Danish possessions to Sweden, but, when the latter strove to annex all Denmark, secured allies and increased his territory. Frederick IV (1671-1730) fought fruitless wars, but founded schools and welfare institutions. Frederick V, 1723-66, ruled well as an enlightened despot. Frederick VI (1768-1839) became regent for his imbecile father by a palace revolution and introduced many reforms, but later became reactionary. He lost Helgoland and Norway in the wars of Napoleon; Frederick VII (1808-63) introduced a democratic constitution, left state affairs to his ministers, and was an able Nordic archae-

ologist. Frederick VIII (1843-1912) introduced a liberal government and free trade reform.

FREDERICK VI (1768-1839), King of Denmark and Norway, was born at Copenhagen, Jan. 28, 1768. His father, Christian VII, was an imbecile, and Frederick was made regent in 1784 and succeeded to the throne in 1808. At the beginning of the Napoleonic wars he resisted England's interference with neutral shipping. England sent a fleet to Copenhagen which defeated the Danish fleet in a decisive battle, April 2, 1801. A few years later the English demanded that the Danish-Norwegian fleet be turned over to them to prevent its use by the French. Frederick refused, and the English fleet bombarded Copenhagen, Sept. 2, 1807. Frederick refused to join the coalition against Napoleon in 1813. As a consequence the powers favored their ally, Sweden, and its new king, Bernadotte, after the overthrow of Napoleon and took away Norway from Denmark and gave it to Sweden. Frederick VI died at Copenhagen, Dec. 3, 1839.

FREDERICK II (1712-86), known as the Great, King of Prussia (1740-86), born on Jan. 24, 1712. He was the son of Frederick William I and the Princess Sophie Dorothea of Hanover. Hoping to instill into his son some of the soldier's virtues which he himself so prominently possessed, Frederick William took pains to outline in detail the type of training that the crown prince was to receive. Much to his father's disappointment, however, young Frederick displayed an utter lack of self-control or self-reliance. The boy, whose main interests were in the fields of literature, poetry, music and art, actually was subjected to the harshest sort of treatment and was restricted to a narrow, pedantic, military training which further and further estranged him from the king. Although Frederick's mother and his elder sister, Wilhelmina, sympathized with his liking for things classical, he eventually became so outraged with his father's methods that he planned to run away. Two of his chums, the Lieutenants von Katte and von Keith, were ready to aid him in this endeavor.

Frederick hoped to escape while on a tour of southern Germany and the Rhine region with his father in the summer of 1730. But the plot was frustrated at Mannheim, due largely to the watchfulness of Lieutenant-Colonel von Rochow, and Frederick was placed under arrest. After a humiliating trial, the prince was sentenced to strict confinement and was compelled to witness the execution of von Katte. Through the intercession of some courtiers, Frederick's punishment eventually was lessened and he was assigned to military duties. Then he was given instruction in matters of finance and commerce, and, in 1733, was forced to marry the Princess Elizabeth Christina of Brunswick-Bevern. In 1734, he served under Prince Eugene of Savoy in the War of the Polish Succession, and, two years later, he and his wife installed themselves in the beautiful castle at Rheinsberg. Here he was able to satisfy and develop to full extent his interests and talents in literature,

music and art, and he began a lively correspondence with Voltaire. He wrote a good deal upon politics and administration, and began more definitely to understand and appreciate his father's military and economic arrangements. A complete reconciliation between father and son, in fact, soon took place.

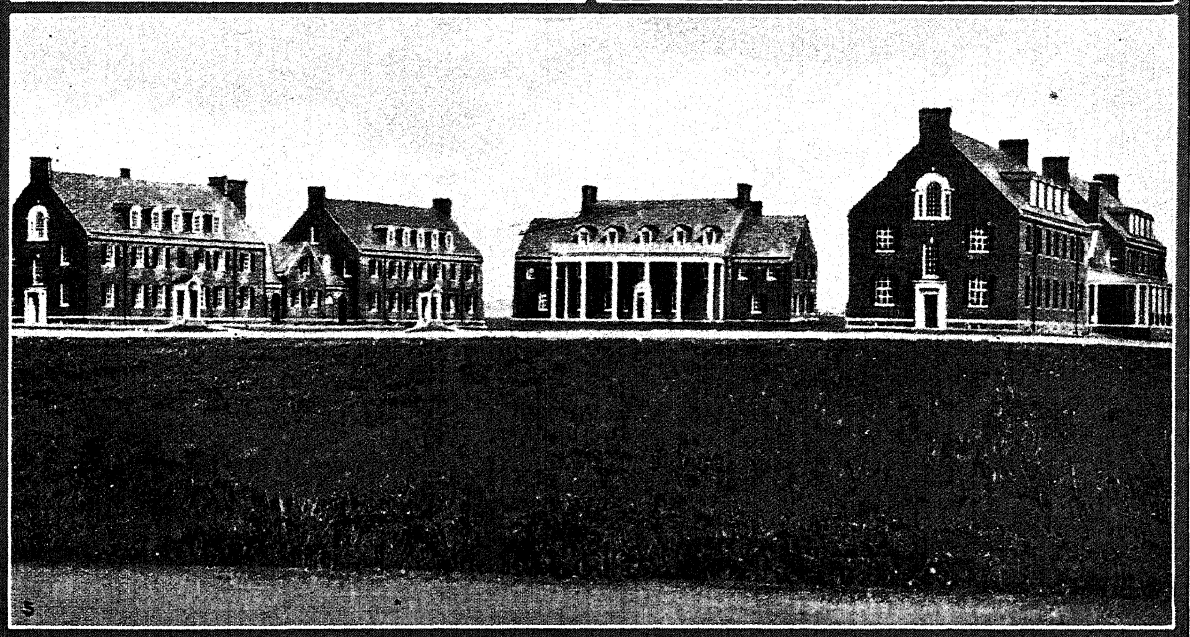
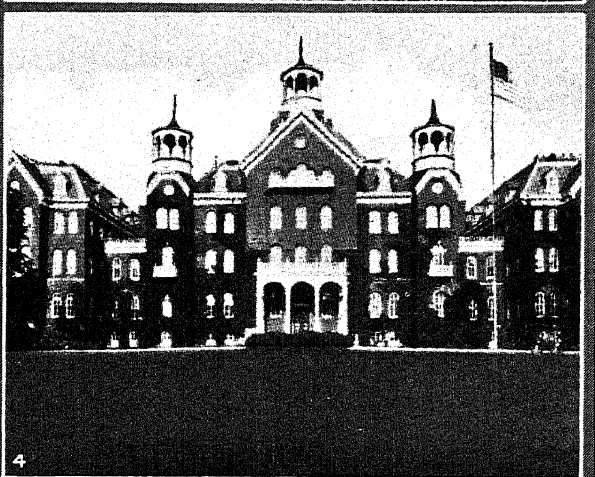
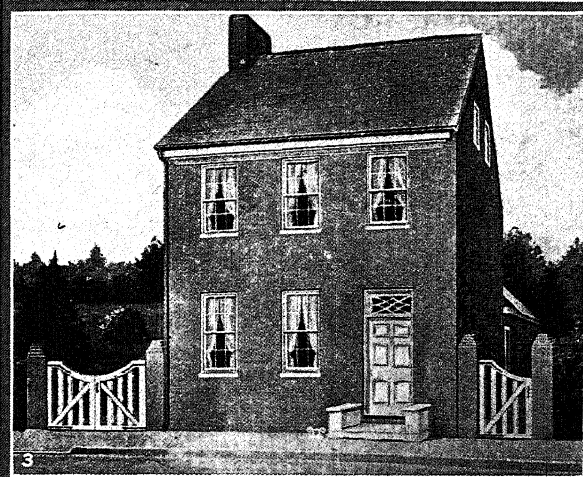
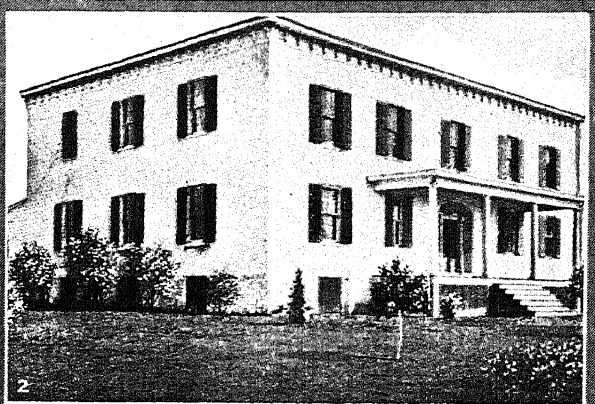
On May 31, 1740, Frederick became king. He now proved to be extraordinarily ambitious and active, proceeding without delay to reorganize the Academy of Sciences, recall some of the leading exiled intellectuals, establish an opera house and encourage the founding of a Berlin newspaper. Press restrictions then were lightened, torture was abolished, the judiciary was reformed, the laws governing the conduct of business and industry were overhauled and the well-functioning bureaucracy established by Frederick William was expanded. Moreover, since it was Frederick's definite aim to enlarge the boundaries of his realm and to gain personal glory in military exploits, he also greatly strengthened the army.

One of Frederick's earliest opportunities for territorial aggrandizement came when, upon the death of the Emperor Charles, who was without male heirs, Maria Theresa inherited the conglomerate Habsburg dominions. Despite the fact that Prussia was a signatory to the PRAGMATIC SANCTION, Frederick at once attempted to deprive Austria of the large and rich German province of Silesia. As a special phase of the War of the Austrian Succession (1740-48), Prussia and Austria accordingly fought the First Silesian War which came to a close with the Treaty of Berlin (1742). The victorious Frederick acquired the coveted region, thereby greatly increasing both the area and the wealth of the Prussian Kingdom. It necessitated a Second Silesian War, lasting from 1744-45, however, before Frederick was confirmed in the possession of this prize.

The next ten years were spent by Frederick in restoring the land and building up the country in accordance with the best and most practical principles of enlightened despotism. He further enlarged the army, fostered trade and industry, kept the tax rate at a relatively low point, encouraged new industries, built canals and roads, founded new villages, sent colonists to the undeveloped agricultural regions, further improved the bureaucratic and judicial branches of the government and supported artistic enterprises from his new palace of Sans Souci at Potsdam, where, from 1750-53, Voltaire was a distinguished, though sometimes aggravating, guest. During these years, the king also wrote much upon history, politics and military strategy, and composed both poetry and music.

At the end of a decade, however, it appeared that Russia, Austria and France were plotting to break the rising power of Prussia. Frederick therefore determined to take quick action to forestall the schemes of his enemies. Supported by his own great ability and energy, by a loyal and prosperous Prussian citizenry and by English money, he waged a successful Seven Years' War (1756-63) against overwhelming

FREDERICK, MARYLAND



FAMILIAR LANDMARKS IN FREDERICK, MARYLAND

1. "Rose Hill," home of Maryland's first governor, Thomas Johnson. 2. "Richfields," birthplace of Admiral Winfield Scott Schley. 3. Home of Supreme Court Chief Justice

Roger Brooke Taney. 4. Administration Building, Maryland School for the Deaf. 5. Maryland Odd Fellows Home. Frederick is a center of historic interest in Maryland.

odds. Thereupon, Prussia secured recognition as one of the major powers of Europe, but the king once more found it necessary to devote his energies to post-war restoration and reconstruction policies.

The state now energetically aided in the rebuilding of villages. In Silesia, alone, 8,000 houses were built or rebuilt within three years with state help. In some cases, taxes were temporarily lightened or suspended and colonists were sent to repair the devastated areas. Arrangements were made whereby landlords might borrow money from the state for the rehabilitation of ruined country estates. In addition, internal trade barriers were decreased in number, trading companies were chartered, commercial treaties were negotiated, state monopolies of various sorts were established, immigration was encouraged, Swabian settlers were sent to build up West Prussia, which had fallen into economic decay under Polish control, swamps were drained, irrigation works were undertaken, administrative reforms in the direction of centralization were begun, serfdom was abolished on the royal domain, a Prussian bank was founded in Berlin and a sizable merchant marine was launched. The barriers between the noble, burgher and peasant classes were carefully maintained, but tolerance was extended to all Christian sects. Judicial reforms were inaugurated, schools and universities were opened and a type of civil service was introduced. Much emphasis was placed upon the progress of culture, science and art. Finally, Frederick left 50,000,000 thalers in the treasury for his successor.

Before the end of his reign, Frederick fought some more wars and annexed additional territory. In August, 1772, he helped in the first Partition of Poland. In 1778, he joined Saxony against Austria in the War of the Bavarian Succession. He several times tried to bring about a federation, or at least an alliance, of German princes under Prussian leadership, but in this sphere he made relatively little progress.

Frederick died of the gout and dropsy, Aug. 17, 1786. Cynical, unscrupulous, patriotic and able, he was the most practical and most successful of the enlightened despots of the 18th century. To the Germans he is still known affectionately as *Friedrich der Einzige*. W. C. L.

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FREDERICK, a city in western Maryland, the county seat of Frederick Co., situated 45 mi. north of Washington. It is served by the Baltimore and Ohio and the Pennsylvania railroads. Frederick is an important trade and manufacturing center in an unusually fertile agricultural region. Its principal industries are flour mills, creameries, canneries, planing mills, foundries, brick factories and knitting mills. The total value of manufactures, 1929, was \$8,897,992. In 1929 the retail business reached a total of \$10,713,313. Settled in 1745, Frederick is rich in

historical associations. It was the home of Francis Scott Key and Barbara Frietchie, and was the scene of several battles in the Civil War. Pop. 1920, 11,066; 1930, 14,434.

FREDERICKSBURG, a city of historic interest in Spotsylvania Co., in northeastern Virginia, situated at the head of navigation on the Rappahannock River, and mid-way between the capital cities Washington and Richmond, being 52 mi. from each. It is served by a municipal airport, steamships, bus and truck lines and two railroads. Transparent cellulose paper, metal egg crates, silk, shoes, clothing, flour, lumber and other products are manufactured. It is the seat of a State Teachers College.

Fredericksburg was settled in 1671, and has a number of places intimately associated with Colonial, Revolutionary and Civil War history. George Washington was educated in the town and the old Masonic lodge, where he was initiated as a Mason, still stands. During the Revolution seven generals from Fredericksburg went to the war, firearms and equipment were made, and a prison camp for Hessian prisoners was established. During the Civil War it was the scene of terrific bloodshed at the BATTLE OF FREDERICKSBURG, and the fighting was even more desperate nearby at the battles of Salem Church, CHANCELLORSVILLE, the WILDERNESS and SPOTSYLVANIA COURT HOUSE. It was at Chancellorsville that Stonewall Jackson fell, accidentally wounded by his own men. Pop. 1920, 5,882; 1930, 6,819.

FREDERICKSBURG, BATTLE OF, Dec. 13, 1862, an engagement of the CIVIL WAR resulting in a major Confederate victory. When, seven weeks after the successful BATTLE OF ANTIETAM, Gen. McClellan had not renewed the attack, he was superseded as commander-in-chief of the Army of the Potomac by Gen. Burnside. Gen. Lee with 78,000 Confederate troops occupied a range of hills south of the Rappahannock, near Fredericksburg, Va. Gen. Longstreet commanded the left wing of the Confederate line, Gen. Jackson the right; Lee personally commanded the center. Burnside grouped his army of 122,000 men into three grand divisions, under Gen. Hooker, center; Gen. Sumner, right wing, and Gen. Franklin, left wing. Stationing a battery under Gen. Hill on Stafford Heights, commanding Fredericksburg on the opposite side of the Rappahannock, Burnside crossed the river and began a desperate attack. The Federal troops made six frantic charges upon Marye's Heights, an impregnable position, each repulsed with great slaughter. Elsewhere the Federal attack was ill-directed and unsuccessful, despite the courage of the junior commanders. The Federal casualties were about 13,000 men; the Confederates lost 4,330. Burnside resigned his command voluntarily, assuming full responsibility for the defeat.

FREDERICK WILLIAM (1620-88), elector of Brandenburg, 1640-88, known as the Great Elector, was born in Berlin on Feb. 16, 1620. He succeeded his father, George William, in 1640 during the Thirty Years' War. By the PEACE OF WESTPHALIA in 1648 he

gained the larger part of farther Pomerania, the bishoprics of Halberstadt, Minden and Cammin and the archbishopric of Magdeburg. His chief accomplishment was the rehabilitation of Germany after the devastating THIRTY YEARS' WAR. He died at Potsdam on May 9, 1688.

FREDERICK WILLIAM I (1688-1740), King of Prussia, was born in Berlin, Aug. 15, 1688, son of Frederick I and his second wife, Sophie Charlotte. His boyhood enthusiasm for the Duke of Marlborough and Prince Eugene, coupled with his natural love of frugality and discipline turned him towards military life. In 1706 he married Sophia Dorothea of Hanover. He ascended the Prussian throne in 1713. One of his first acts was to declare war on Charles XII of Sweden, thus making good his title to Pomerania. His sense of justice however impelled him later to make a fair payment to Sweden. He made alliances with Russia, England, and Hanover. He more than doubled the strength of Prussia's army and took a naïve pride in the extraordinary and uniform height of his palace guard. In the conduct of internal affairs, Frederick William displayed a sense of social justice rare in his day. He awarded the royal domains to the nation, placed the serfs thereon at liberty, and abolished the hereditary lease on the royal lands. He fostered Prussian industry by prohibiting the importation of goods made abroad. He died at Potsdam, May 31, 1740.

FREDERICK WILLIAM III (1770-1840), king of Prussia, was born at Potsdam, Aug. 3, 1770, the grandnephew of Frederick the Great. In 1793 he married the Princess Louise of Mecklenburg-Strelitz, a woman of great beauty and nobility of character. On his accession in 1797, he endeavored to restore the country which had degenerated under the misrule and extravagance of his father, but the rising power of Napoleon did much to hinder him. After the disastrous defeat at Jena in 1806, all Prussian lands west of the Elbe were occupied by the French and at the peace of Tilsit in 1807 he was forced to part with half of his kingdom. Queen Louise, by far his superior, died in 1810, worn out by anxiety. After the defeat of Napoleon in 1813 Frederick William reoccupied much of the lost territory, entered Paris with the allies in 1814 and again in 1815 and took part in the Congress of Vienna which gave to Prussia about two-fifths of Saxony, Westphalia, Posen and Rhenish Prussia on the left bank of the Rhine in return for Polish territory, notably Warsaw, given to Russia. Thoroughly reactionary and under the influence of Metternich he fulfilled none of the expectations of the War of Liberation and Prussia with Austria became a stronghold of reaction till 1808. On the other hand he adopted an enlightened economic policy, especially in the tariff system, which was gradually joined by the other German States save Austria to form the Zollverein or Prussian Customs Union. He died at Berlin, June 7, 1840.

FREDERICK WILLIAM IV (1795-1861), King of Prussia from 1840 to 1861. He was the son of

Frederick William III and the older brother of the first German Emperor, William I. He was of romantic and somewhat vague liberal tendencies, which led him to call a united Landtag of Prussia in 1847 to study reforms. When the revolution broke out in March, 1848, he hesitated to employ harsh methods, yielded to the revolutionaries, and called a constituent assembly to draft a constitution for Prussia, despite the fact that he had previously declared that he would never allow "a miserable sheet of paper like a constitution to come between him and his dear subjects." The revolution collapsed before the year was out, but Frederick William kept his promise and proclaimed the new constitution in 1850. It was, however, ultra-conservative in character, providing for exceptional royal prerogatives and the three-class system of voting, which practically disfranchised the masses of the taxpayers. In 1857 his mind became affected and the following year his brother William was made regent. Frederick William died in 1861.

FREDERICTON, a city, county seat of York Co., and capital of New Brunswick, Canada, situated on the St. John River, 68 mi. northwest of St. John. Because of its accessibility on the navigable river, Fredericton is the provincial center of industrial and agricultural commerce. Lumbering and the grain trade are important, and there are cotton and woodenware manufactures and tanneries. The city is well-planned and substantially built, with the provincial parliament buildings, an Anglican cathedral among many churches, two parks, and educational foundations including the University of New Brunswick. The king's provision store, built before 1788, still stands. Fredericton was founded by Thomas Carleton in 1788, and incorporated 1848. It was made the provincial capital instead of St. John for reasons of policy. Pop. 1921, 8,114; 1931, 8,828.

FREDONIA, a village in Chautauqua Co., in southwestern New York, situated near Lake Erie, 45 mi. southwest of Buffalo. It is served by the New York Central Railroad. The important industries are fruit and vegetable canning and the manufacture of grape products, especially grape-juice. The Woman's Christian Temperance Union and the Patrons of Husbandry (Grange) were founded in Fredonia. A state normal school is located in the village. Fredonia was settled in 1804, and 25 years later it received its first charter. In 1821 the village streets were lit with gas from the first natural gas well drilled in the United States. Lafayette visited Fredonia in 1825. Pop. 1920, 6,021; 1930, 5,814.

FREDONIAN WAR, 1826-27, a premature attempt of Anglo-Americans to achieve the independence of Texas from Mexico. Hayden Edwards secured in Apr. 1825, a concession for colonizing a tract about Nacogdoches, in eastern Texas. He and his brother, Benjamin W. Edwards, came into conflict with the Mexican authorities over questions of prior grants in the tract and of fees to be collected from settlers, and the concession was revoked. On Dec. 16, 1826, Benjamin Edwards and 15 men rode into

Nacogdoches and proclaimed an independent republic, Fredonia. A government was organized, and treaties made with 23 Indian tribes, establishing an offensive alliance contemplating the partition of Texas between the Indians and the Anglo-Americans. The largest and most influential colony in Texas, Stephen F. Austin's, refused to participate; its abstention was fatal to the movement. On Jan. 4, 1827, Samuel Norris, heading a party of opposition in Edwards' colony, led a force of about 60 men, mostly Mexicans, to Nacogdoches to capture the Fredonian garrison. They were opposed and routed by a tiny force of 11 Fredonians and 9 Indians, in the one actual battle of the "war." A body of Mexican troops reached Nacogdoches shortly afterward to find the republic dissolved.

FREDRIKSHALD. See HALDEN.

FREDRIKSTAD, a city of Norway in the district of Ostfold at the confluence of the Glommen and the Oslo Fjord on the railway between Oslo and Göteborg. There is a good harbor, and industries include a calcium carbide factory and a sawmill and exportation of lumber. Pop. 1930, 14,053.

FREEBOARD, a term applied to ocean going vessels with freeboard markings, is the distance between the markings (often called Plimsol line) located at the middle of the load water line to the freeboard deck.

Various rules for many years were used by the Board of Trade, London, Lloyd's and American Bureau of Shipping for arriving at the freeboard to be assigned vessels. These different rules often caused confusion, to do away with which an international conference was held in London, in 1930, where delegates from various countries interested in shipping attended. Considerable was accomplished at the conference and progress made in arriving at standardized methods for making freeboard calculations and assigning markings.

In making freeboard calculations the arrangement and construction of a ship, the trade she is to be used in and route run on have to be considered. The rules to be followed are outlined in Regulations for the Establishment of Load Lines, published by the Department of Commerce.

Having made the necessary calculations there is center punched and then painted in white on both port and starboard sides of a vessel amidships, freeboard marking. The mark shows the lowest load line, that a vessel can be loaded to for certain routes and times of the year. If this loading is exceeded, the captain and his company are liable to fines.

BIBLIOGRAPHY.—*Regulations for the Establishment of Load Lines*, U.S. Department of Commerce; Lloyd's Rules; American Bureau of Shipping Rules.

FREE CITY, the title given to a city which is an independent state. Under the constitution of the German Empire of 1871 it is applied to the three German cities, Bremen, Lubeck and Hamburg. All of these three were Hanse cities which had joined the German Empire at the time of its formation. The World War

led to the formation of one additional free city, Danzig, which because of its German population, was excepted from former Prussian territory ceded to Poland.

FREEDMEN'S BUREAU, properly Bureau of Refugees, Freedmen, and Abandoned Lands, established by act of Congress Mar. 3, 1865, for the supervision of lands abandoned in consequence of the defeat of the Confederacy, and of "all subjects relating to refugees and freedmen." The president was authorized to appropriate confiscated and abandoned lands in the southern states for the temporary use of the freedmen. Food, clothing and fuel were to be distributed through the bureau to destitute Negroes and loyal refugees. The bureau was also to act somewhat as an employment agency and to further the education of the Negroes. The act was operative until one year after the conclusion of the war. A bill of Feb. 6, 1866, continuing its operation, was vetoed by President Johnson; but a second bill, the Act of July 16, 1866, was passed over his veto. The bureau's powers were increased, despite that an investigation by Generals Steedman and Fullerton, directed by the president, had disparaged its management. The sale of Confederate public property for educational purposes was authorized. The bureau was given military jurisdiction over infringements of civil rights which its procedures attempted to secure to the freedmen. Handicapped by the active hostility of the native whites, and by the attitude of a large proportion of its officials whose interest was in personal aggrandizement or power, the bureau performed excellent humanitarian service and greatly advanced education among the freedmen. HOWARD UNIVERSITY was named in honor of Gen. Oliver O. Howard, the commissioner of the bureau. The Act of 1866 expired, by its statutory provision, in 1868. The duration of the bureau was extended in unreconstructed states to Jan. 1, 1869, and the educational work was continued until July, 1870.

FREEDOM OF CONTRACT, the right or privilege of a person to enter into lawful contracts. Such liberty of contract is guaranteed to citizens of the United States by force of the 14th Amendment to the Constitution. Moreover, the 14th Amendment is not confined to the protection of citizens alone but extends to all persons without regard to difference of race, color or nationality. (*Yick Wo v. Hopkins*, 118 U. S. 357, 358). One example of observance of the principle of freedom of contract is found in the decisions holding unconstitutional and invalid statutes which tend to restrict or regulate contracts between employers and employees. It has been said, however, that there is no such thing as absolute freedom of contract. "Liberty implies the absence of arbitrary restraint, not immunity from reasonable regulations and prohibitions imposed in the interests of the community." (219 U. S. 566, 567.) In accordance with this policy the Supreme Court of the United States has held that a statute regulating the hours of labor for women engaged in particular occupations is a reasonable exercise of the police power of the state.

In such case there is no violation of the principle of liberty of contract even though, in the interests of public health, persons are prohibited from entering into contracts contrary to the statute.

FREEDOM OF THE SEAS, in general the right, long recognized by international law, of every nation to the free and unrestricted use of the high seas in time of peace. In time of war the right is subject to severe restrictions. Belligerents (*see* BELLIGERENCY) may engage in battle on the high seas in which case neutrals may suffer risk as well as inconvenience. Belligerents may also exercise the right to stop, visit and search the merchant vessels of neutral states.

FREEHOLD, a borough and the county seat of Monmouth Co., N.J., located on the Pennsylvania and the Central of New Jersey railroads, 42 mi. south of Newark, N.J. It is the trading center for a productive agricultural area and is also the site of a number of industrial establishments, including rug factories and an iron foundry. Freehold, originally known as Monmouth Court House, was founded in 1715 and was the scene of an important engagement in the Revolution. It was incorporated as a town in 1869 and received its charter as a borough in 1919. Pop. 1920, 4,768; 1930, 6,894.

FREEHOLDER, any person holding real estate in fee, or in the United States any owner of real property. In England and colonial America, freeholder status was a common qualification for voting and holding office. In New Jersey there are Boards of Chosen-Freeholders corresponding to the board of supervisors or county commissioners in other states. *See also* HOME RULE, MUNICIPAL.

FREELAND, a borough of Luzerne Co., north-eastern Pennsylvania, situated on Broad Mountain, 18 mi. south of Wilkes-Barre. Agriculture and coal-mining are the chief interests of the countryside. The borough has silk, bobbins, shirt and cigar factories and machine shops. Pop. 1920, 6,666; 1930, 7,098.

FREEMAN, EDWARD AUGUSTUS (1823-92), English historian, was born at Harboone in Staffordshire in 1823. Educated at Oxford, he became a fellow in 1845. He interested himself in foreign politics, particularly the struggles for independence of the smaller countries of eastern Europe. He supported Gladstone in domestic affairs. As a result of his interest in politics, he coined the much-quoted saying, "History is past politics, and politics is present history." He published many books and a great many articles for periodicals. In the *Saturday Review* he carried on a sustained attack on Froude. In 1854 he was made Regius professor of modern history at Oxford. His principal work, *History of the Norman Conquest* in 15 volumes, published in 1867-76, had for its theme the continuation of Anglo Saxon stock regardless of the Norman conquest and the importance of its elements as a constitutional basis. He died at Alicante, Spain, on Mar. 6, 1892.

FREEMAN, JOHN (1885-1929), English poet and critic, was born in 1885. His poems, especially his pastorals, have great beauty of form and unusual

spiritual power. As a critic, Freeman is particularly noted for his biography of HERMAN MELVILLE and his *Portrait of George Moore*. In 1920 the Hawthorndon Prize was awarded him for his writings. His publications include *English Portraits and Essays*, *God's Infidel*, *Prince Absalom*, *The Red Path* and *Solomon and Balkis*. Freeman died at Annerley, England, Sept. 23, 1929.

FREEMAN, MARY ELEANOR WILKINS (1862-1930), American writer, was born at Randolph, Mass., Jan. 7, 1862. When about 20 she began to contribute to the various magazines, and her stories of New England life soon attracted attention. In character delineation she inclined to the morbid traits produced by a barren country existence, and she excelled in the short story. Her work, because of its stark realism, is in marked contrast to that of SARAH ORNE JEWETT. Mrs. Freeman's works include *A Humble Romance and Other Stories*, 1887, *Jane Field Pembroke* and *A New England Nun and Other Stories*, 1920. She died at Metuchen, N.J., Mar. 13, 1930.

FREEPORT, a city of northern Illinois and county seat of Stephenson Co., on the Pecatonica River, 121 mi. northwest of Chicago. The city's transportation facilities include the Illinois Central, the Chicago and North Western, the Chicago, Great Western and the Chicago, Milwaukee, St. Paul and Pacific railroads. It derives trade from the surrounding dairying and farming country, and manufactures a variety of commodities ranging from windmills to coffee mills. In 1929 the value of the factory output was about \$24,000,000; the retail trade amounted to \$14,643,054. The **FREEPORT DOCTRINE** was presented by Stephen A. Douglas in a debate with Lincoln, August 27, 1858, on a spot now marked by a granite boulder. White Pines Forest State Park lies within 25 mi. south of Freeport. A settlement of 1835 on the site of Freeport was named Winneshiek in 1836 and renamed in the year it became the county seat, 1837. Freeport was incorporated in 1850 and received its city charter in 1855. Pop. 1920, 19,669; 1930, 22,045.

FREEPORT, a village in Nassau Co., a strictly residential suburb of New York, situated on the western end of Long Island, 24 mi. from Brooklyn, New York City; it is served by the Long Island Railroad and bus lines. Freeport is adjacent to navigable waters leading to adjoining bays and the Atlantic Ocean, and it is the trading center for 17 outlying communities. The retail trade in 1929 reached a total of \$13,055,411. Pop. 1920, 8,599; 1930, 15,467.

FREEPORT DOCTRINE, the theory enunciated by STEPHEN A. DOUGLAS in public debate with his rival for the senate, ABRAHAM LINCOLN, at Freeport, Ill., 1858, in answer to Lincoln's question: Could the people of a territory, in view of the Supreme Court's decision in the DRED SCOTT CASE that slaves were property and that their owners were protected by the Constitution in all the territories, exclude slavery from their territory by any lawful means? Douglas replied that by failure to enact the police regulations

necessary for the existence of slavery in a community, or by passing "unfriendly legislation," the people of a territory could practically exclude slavery. This temporizing answer materially weakened Douglas's strength in the nation, and was the chief reason why many southerners bolted the Democratic Party in 1860, organizing an independent party rather than vote for Douglas for president.

FREE PORTS. See **PORTS**.

FREESIA, a genus of attractive perennials of the **IRIS** family. There are three species, native to South Africa, numerous varieties of which are grown as ornamentals. They are small plants, with slender branching stems, bearing narrow leaves and a few very fragrant flowers in loose clusters. The funnellform flowers, with slender tubes an inch or two long, vary in color from bright yellow to orange, rose-purple, and white.



FREESIAS

FREE SILVER, a term meaning that the government mints will accept in unlimited quantities silver

bullion for coining into money which is full **LEGAL TENDER** in the payment of debts both public and private. A slight charge for the coining operation may or may not be made. The expression free silver has been used more commonly to refer to free coinage of silver in conjunction with free coinage of gold and at a fixed ratio with gold. Thus, at a ratio of 16 to 1, the mints would receive and coin 16 ounces of silver into the same number of dollars as would be coined from one ounce of gold. Free silver in this sense means the same thing as **BIMETALLISM**.

The term free silver was used in the agitation in the United States over the free coinage of silver following the fall in the gold price of silver in 1874 to a point where the metal in the silver dollar was worth less than one dollar. Prior to this time the silver in the silver dollar was worth more than one dollar; consequently, no silver was brought to the **MINT** for coining into silver dollars. In an act passed in 1873 the silver dollar had been omitted from the list of coins provided for. This was done with little discussion and attracted but slight attention, since no one had desired to bring silver for coining into dollars. Although this situation had existed for a generation, yet the next year, 1874, the price of silver fell to a point where silver could profitably be taken to the mint for coining. The public then discovered that the free coinage of silver dollars no longer existed. This marked the beginning of the agitation for free silver which continued until the defeat of **W. J. BRYAN** in the presidential election of 1896.

J. P. Y.

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FREE SOIL PARTY, a political party in the United States participating in the presidential elections of 1848 and 1852. Designed to unite the **LIBERTY PARTY** supporters, the **BARN BURNERS**, the **CONSCIENCE WHIGS** and others opposed to the extension of slave territory, the party was organized in convention at Buffalo, in Aug. 1848. **MARTIN VAN BUREN**, already named by the Liberty party and by a convention of barn burners, was its nominee for the presidency, and **CHARLES FRANCIS ADAMS** for the vice-presidency, "upon the national platform of freedom as opposed to the sectional platform of slavery." Van Buren had never been prominently identified with antislavery, and the **SEWARD WHIGS** refused to join the Free Soil Party because of his nomination. The party campaigned earnestly upon a platform demanding the barring of slavery from national territory by national power; the abolition of slavery in the District of Columbia, from all public works and buildings of the United States; prohibition of interstate and coastwise slave trade, and the nullification of the **FUGITIVE SLAVE LAW** by leaving its enforcement to the option of the several states. The platform was too radical in 1848, and the conservative antislavery vote remained Whig; Van Buren polled 291,263 votes, insufficient to threaten Taylor's majority. In 1849 the party elected **SALMON PORTLAND CHASE**, Ohio, to the Senate, and 1851 sent **CHARLES SUMNER**, Massachusetts, to the same body. In the national election of 1852 the party, assailing the finality of the **COMPROMISE OF 1850**, met little popular success; its nominee for president, John P. Hale, received only 156,149 votes. In 1856 the Free Soil men joined the **REPUBLICANS**.

FREETOWN, an important seaport and the capital of Sierra Leone, West Africa, a protectorate of Great Britain. It is a valuable coaling station and export point for palm oil, nuts, rubber and gums. The city is built on high land near many malarial swamps, most of which have been drained or filled to safeguard health. The population is predominantly native. Pop., 1921, 44,142.

FREE TRADE. See **PROTECTION AND FREE TRADE**.

FREE VERSE. See **VERS LIBRE**.

FREE WHEELING. See **CLUTCHES**.

FREE-WILL, the doctrine that the will is free, or at least that it is not completely determined. It varies according to meaning of terms and the extent to which freedom is admitted. In its extreme form it is known as **LIBERTARIANISM**, although there is even room for a difference among the libertarians. Free-will is sometimes identified with sheer arbitrariness in choice; others hold that such a freedom is not freedom at all, but that it would be the worst kind of anarchy. The issue between free-will and **DETERMINISM** has never been exactly settled; it has simply been outgrown. The only sense in which free-will has any meaning is in the freedom of choice. Nor is this absolute, but rather relative. That we do have a certain power to choose between alternatives seems fairly sure. It is easy enough to argue it away, but nevertheless there are times when we feel free to choose.

It is as dogmatic to insist that nature throughout must obey rigid and mechanical deterministic principles as it is to hold to an extreme form of libertarianism. The truth is probably found at some middle point. Our conceptions of science have been influenced largely by the physical sciences; but with the growth and development of the biological sciences, and particularly the social sciences, we have begun to realize that the concepts of physical science do not always fit. To deny the existence of a certain amount of freedom because of preconceived notions of science is itself unscientific. It is the business of science to explain phenomena and to develop concepts that are adequate to such explanation rather than to deny phenomena because its early concepts do not cover them.

The conceptions of creative and emergent evolution have done much to bring free-will and determinism together. Nature presents varied phenomena, and its upper strata cannot always be explained by conditions at the lower levels. The principle of self-determinism has also helped to square a relative amount of freedom with a relative amount of determinism. Even in the physical sciences the old mechanical idea of causation has given way to a limited indeterminism. Matter is no longer regarded as something inert and merely mechanical. Our so-called scientific laws are nothing but statements of the habits of nature. But all of nature's habits are not equally rigid. This gives rise to different degrees of indeterminism and the possibility of freedom. See WILL, FREEDOM AND TRAINING OF THE.

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FREE ZONES, or free ports established within the political boundaries of a state, are areas into which foreign products may be imported without payment of duty. Raw materials may be imported, manufactured and reshipped. Lubeck, Bremen and Hamburg are among European cities maintained as free zones at the present time. In the Far East, Singapore has a similar status.

FREIBERG, a German town, located in Saxony about 20 mi. southwest of Dresden. It is the oldest mining town in Saxony. The town is surrounded by promenades and has a late-Gothic cathedral. There is also a mortuary chapel of the Protestant Saxon electors. The oldest secular buildings are the 12th century castle and the rathaus. Freiberg was the center of the Saxon mining industry, beginning in the 12th century and ceasing in the 19th. The Mining Academy still exists. The development of the town followed the discovery of silver near the Abbey of Altselle. Pop. 1925, 34,742.

FREIBURG, a German city in the southern part of Baden at the edge of the Black Forest. It lies among wooded hills and the old city, with its medieval houses, lies on the slope of a hill surmounted by a castle. A number of attractive suburbs lie about the town. Of the 18 churches, the most interesting are the archiepiscopal cathedral of the 13th century, formerly the minster, and the University Church of the

17th century. The rathaus is of the 16th century. The town has a university which was founded in 1457 and which had over 3,000 students in 1925. There are large libraries and art collections. Pop. 1925, 90,475.

FREIGHT, goods carried for hire by COMMON CARRIERS. The total revenue tons transported by Class I carriers in the United States during recent years were as follows:

1925	2,304,274,746
1926	2,465,368,606
1927	2,363,638,942
1928	2,361,622,636
1929	2,451,601,084
1930	2,063,077,591

It is ordinarily assumed that the variety of products shipped by rail is enormous, and this is true if the freight is finely classified; but it is also true that about 60% of the entire tonnage of the railroads of the United States in 1930, consisted of coal, gravel, logs and lumber, iron, grain, and petroleum and petroleum products. Inland waterways also carry a high percentage of low grade traffic; on the other hand, motor trucks handle a much larger share of perishable goods and of miscellaneous package freight.

The average railroad receipts for the carriage of one ton of freight one mile were, in 1930, 1.063 cents. In spite of this extraordinarily low charge the rail carriers earned \$4,086,000,000 out of \$5,343,000,000 or 76% of their total revenues in 1930 from their freight business. The peculiar achievement of American railroads is their efficient handling of cheap, heavy commodities moving long distances in large unit quantities. Evidence of this may be found in the fact that, in 1930, the average train load was 785 tons, while, in spite of an increasing train load the speed of freight trains during the past ten years has considerably increased. S. D.

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FREIGHT CAR. See RAILROAD ROLLING STOCK.

FREIGHT HANDLING EQUIPMENT. See MATERIALS HANDLING.

FREIGHT YARDS. See RAILROAD YARDS.

FREISCHÜTZ, DER, an opera in three acts by C. M. von WEBER, libretto based on an old legend by Kind; première, Berlin, 1821, London, 1824, New York, 1825. The first of Weber's three operas which attained substantial popularity, it also stands first in general favor.

Having sold himself to the Devil, Kaspar acquires the power of a Freischütz or free-shooter—one whose aim is infallible since he has magic bullets. As his period of bondage on earth is nearly over, Kaspar needs to find a substitute victim for Zamiel, the wild huntsman who is his master, otherwise his own

soul will shortly be placed in forfeit. Max, a fellow forester, seems a likely substitute because he has been promised the hand of Agatha, daughter of Cuno, the hereditary keeper of the Bohemian forest, if he wins at a shooting contest soon to be held. The would-be bridegroom is a peculiarly likely candidate because, although ordinarily an excellent marksman, he has lately made a poor showing at target practice. Without much difficulty, therefore, Kaspar persuades Max to go with him to the Wolf's Glen where together they mould seven magic bullets, six of which will go to their mark infallibly while the seventh may be shot at will. Max is confident of the outcome of the contest he is to enter, since Kaspar has demonstrated the efficacy of the magic bullets. Unfortunately, prior to the actual contest, Max has exhausted six of the bullets while exhibiting his remarkable skill as a huntsman; but a single one remains, and this is the one in Zamiel's power. Taking careful aim, while the assembled throng watches the test shot eagerly, he is on the point of shooting a passing dove when Agatha cries out in desperation. But it is too late to stay his finger, even though the girl has been transformed into the bird at which he aimed. Max fires the seventh and last shot which lodges, not in the heart of his beloved, but in Kaspar himself who, for tempting Max into the Wolf's Glen, is slain by Zamiel in retribution.

FREMIET, EMMANUEL (1824-1910), French sculptor, was born at Paris, June 12, 1824. His career was a curious combination of science and sculpture. He was driven by poverty from osteological studies to the post of painter to the Morgue. Fremiet executed equestrian statues such as the *Joan of Arc*, in the Place des Pyramids, Paris, and the powerful *Du Guesclin* at Dinan; animal pieces, and such combinations as the *Ourang-Outangs* and *Borneo Savage*, at the Paris Museum of Natural History, where Fremiet succeeded Bayre as professor of animal drawing. He died at Paris, Sept. 10, 1910.

FREMONT, JOHN CHARLES (1813-90), American explorer, soldier and political leader, was born in Savannah, Ga., Jan. 21, 1813. He received A.B. and A.M. degrees at Charleston College, and he served as teacher of mathematics on the *Natchez*, a sloop of war, during a South American cruise. In 1838, he refused an appointment as mathematics professor in the navy and joined a railroad survey party as assistant engineer. After further surveying explorations about the headwaters of the Mississippi River, Fremont, in 1842, crossed the Rocky Mountains, and in the following year explored unknown northwestern country. On another exploring expedition, begun in 1845, he came into conflict with the Mexican authorities when they refused him permission to work in their territory beyond Monterey in March, 1846; and when the war with Mexico broke out, he rid northern California of Mexicans. In 1848, he led a fourth expedition to the upper Rio Grande to survey a route for a railway to the Pacific, but was obliged, after great suffering, to return to

Santa Fe. He then settled in California, and, in 1850, represented the new state in the Senate. Failing in re-election to the Senate, he conducted a fifth expedition for the purpose of establishing a central route to the Pacific, but accomplished little. In 1856, he was the anti-slavery candidate for the Presidency. He served as major-general in the Union Army in 1861-62. From 1878 until 1881, he was Governor of the Territory of Arizona. He died in New York, July 13, 1890.

FREMONT, a city of eastern Nebraska, the county seat of Dodge Co. It is situated on the Platte River and four main highways, about 38 mi. northwest of Omaha, and at an altitude of 1,197 ft. Three railroads and nation-wide bus systems provide transportation. Industries include canning, milling and manufacturing. The city is an important grain market and retail trade center. In 1929 the retail trade amounted approximately to \$8,460,000. It also has incubator and refrigerator factories, poultry packing houses and various other industrial plants. Stock, dairy and poultry farms are operated in the vicinity, and corn is the chief crop. The city, named after Gen. John C. Freeman, was incorporated in 1859. Here are situated Midland College and Western Theological Seminary. Pop. 1920, 9,592; 1930, 11,407.

FREMONT, a city of northern Ohio and county seat of Sandusky Co., on the Sandusky River, 32 mi. southeast of Toledo. The New York Central, the Lake Erie and Western, and the Wheeling and Lake Erie railroads serve it; boats operate between Fremont and Lake Erie ports, and there are several bus and truck lines affording transportation. Fremont is supplied with natural gas and manufactures products which had an approximate valuation of \$11,000,000 in 1929. The retail trade in the same year amounted to \$8,766,158. Spiegel Grove Park, formerly the home of President RUTHERFORD B. HAYES, was presented by his heirs to the Ohio Archaeological Society. Fremont traces its history to a trading-post of 1785. In 1812 Ft. Stephenson, then an Indian rallying-place called Lower Sandusky, was erected on this site. It was attacked, Aug. 1-2, 1812, by Gen. Proctor, commanding a British and Indian force of 1,300, and was successfully defended by 160 Americans under Major George Croghan, with minor casualties. In 1906 the remains of Major Croghan were interred in Fort Stephenson Park, in the heart of the business district of Fremont. The settlement was renamed in 1866 to honor J. C. Fremont. Pop. 1920, 12,468; 1930, 13,422.

FREMONT PEAK, one of the highest points in Wyoming, contained in the Wind River Mountains, a section of the Rockies. It occurs in Sublette Co. near 43° 8' N. lat. and attains a height of 13,730 ft. above sea level. Lake Fremont, one of the largest in Wyoming, extends 8 mi. from its eastern base. This peak was first explored and measured in 1842 by JOHN C. FREMONT who was making scientific investigations of the west.

FREMSTAD, OLIVE NAYAN (1870-), Swedish soprano, was born at Stockholm in 1870. She

made a public appearance as a pianist at the age of 5. In 1880 she came to the United States, where she taught music in 1887-91 in New York and Chicago. In 1892 she returned to Europe to study singing with Lilli Lehmann. She made her operatic début at Cologne in 1898, appearing as Azucena in *Il Trovatore*. During 1903-14 she sang the principal Wagnerian rôles at the Metropolitan Opera, New York, in 1907 creating the part of Salome in the opera by Richard Strauss. Her chief rôles were as Carmen, Kundry, Brünnhilde, Venus, Elsa, Isolde, and Tosca.

FRENCH, ALICE (1850-), American author who wrote under the pen name of Octave Thanet, was born at Andover, Mass., Mar. 19, 1850. She was educated at the Abbot Academy, Andover. Her first writings were on economic and sociological subjects, but she soon turned to the short story. She moved to Iowa and later to Arkansas and these states have furnished the scene for most of her work, which includes *The Heart of Toil*, 1898, *The Man of the Hour*, 1905, *Stories That End Well*, 1911, *A Step on the Stair*, 1913, and *The Captain Answered*, 1917.

FRENCH, DANIEL CHESTER (1850-1931), American sculptor, was born at Exeter, N.H., Apr. 20, 1850. The statue of the *Minute Man*, commissioned by the town of Concord, Mass., for the centenary of the Battle of Concord, was executed at the age of 23. The Gallaudet Monument, Washington, marked the appearance of that strain of pathos which detracted from the pure sculptural quality of such works as the *Death and the Sculptor* relief, in the Forest Hills Cemetery, Boston, and the Alice Freeman Palmer Memorial, at Wellesley College. The colossal *Statue of the Republic*, at the Chicago World's Fair, was followed by the *Alma Mater*, at Columbia University, the figures of the Continents on the facade of the New York Customs House, and the huge, seated Lincoln, in the Lincoln Memorial at Washington. This statue, which is cut from 20 blocks of Georgia marble, is the largest piece of sculpture in America. French's reliefs include the bronze doors of the Boston Library and the stone frieze upon the façade of St. Bartholomew's Church, New York, done in collaboration with Andrew O'Connor. French's idealized women, in spite of their huge scale, often lack grandeur. Nor are his heavy winged angels entirely successful. It is in the simply composed and keenly characterized male portraits, such as the early busts of Harvard, Emerson and Alcott and the more recent, seated Emerson, that the artist is most American and most himself. French died at New York City, Oct. 8, 1931.

FRENCH, EDWIN DAVIS (1851-1906), American engraver, was born at North Attleboro, Mass., June 19, 1851. He began commercial engraving on silver in 1869. He achieved a reputation as a designer and engraver of bookplates, which he executed for members of the Grolier Club and the Union League. He also made engravings for the Metropolitan Museum and the Dean Hoffman Library. He died at New York City, Dec. 8, 1906.

FRENCH, SIR JOHN DENTON PINKSTONE (1852-1925), First Viscount, English soldier, was born at Ripple, Kent, Sept. 28, 1852. He entered the navy in 1866, transferring to the army eight years later, and served with distinction in the campaigns of the Sudan and the Boer War. He became lieutenant-general in 1900, general in 1907, and field-marshal in 1913. He was the first commander-in-chief of the British expeditionary forces in Belgium and France in the WORLD WAR, and held that post for 16 months, a period which included the Mons retreat and the battles of the Marne, Ypres, and Neuve Chapelle. For his services he was created viscount. He died at Deal, England, May 22, 1925.

FRENCH AND INDIAN WAR, THE, 1754-63, the struggle between the French and English in America, closely related to the SEVEN YEARS' WAR in Europe. In essence it was a contest for the possession of the Ohio valley. In 1749 Celeron de Bienville took formal possession of the disputed region in the name of France. In the next few years the French erected a chain of forts between Lake Erie and the falls of the Ohio. Gov. Dinwiddie (*see* DINWIDDIE, ROBERT) of Virginia despatched an expedition to the disputed frontier; hostilities began when a detachment under GEORGE WASHINGTON encountered and defeated a French force under Jumonville. In 1755 Gen. Braddock led an army of British regulars, augmented by Virginia militiamen, against Ft. Duquesne, the French stronghold at the Forks of the Ohio; on July 9th his army was ambushed and Braddock slain. The French maintained their control of the Ohio valley against a series of isolated, half-hearted campaigns, until Nov. 25, 1758, when Ft. Duquesne was abandoned and burned at the news that Gen. Forbes with an army of about 6,000 men, mostly colonial militia, had surmounted the Pennsylvania wilderness and was about to attack the fort. On the northern border and at sea the British campaign was mainly a succession of disasters and failures until in June, 1757, WILLIAM PITT became Prime Minister. He prosecuted the war with masterly ability, effecting a reorganization of the British army in America under Generals Howe, Forbes, Amherst and Wolfe. An army of over 11,000 troops under Amherst and Wolfe captured Louisburg on July 26, 1758; exactly a year later Ft. Ticonderoga, at the head of LAKE GEORGE, was abandoned by the French at the approach of a superior force under Amherst. In the summer of 1759 the British besieged the capital of New France, Quebec, thought to be impregnable. On Sept. 13, 1759, after a spirited action distinguished by the bravery of the rival commanders, Wolfe and Montcalm, Quebec was captured, practically ending the war. The TREATY OF PARIS, 1763, divided the French possessions in America between England and Spain.

FRENCH DRAMA. French serious drama dates from about the year 1000. It was born of religion, springing from dialogues in the church service. The oldest extant French drama played outside the church was the *Représentation d'Adam*, dating from the 12th

century. The only important liturgical plays of the 13th century were the *Jeu de Saint Nicolas*, by Jean Bodel, and the *Miracle de Théophile*, by Rutebeuf. The outstanding serious play of the 14th century was the miracle play of which 42 examples remain. In the next century there developed the MYSTERY PLAYS, finally forbidden by the Parliament of Paris in 1548 because they had degenerated into unwholesome abuse.

The French comic theater was of spontaneous growth, the earliest comic actors being the *jongleurs*. The first dramas of this type were the *Jeu de la feuillée*, about 1262, and the *Jeu de Robin et de Marion*, both by Adam de la Halle. The former consists largely of satirical invective; the latter is a simple pastoral with musical accompaniment. In the 15th century three comic forms were conspicuous: the morality play (see MORALITIES), in which rules of conduct were represented in allegorical form; the *sottie*, in which human follies were portrayed; and the FARCE, of which the most representative is the famous *Pathelin*.

In the 16th century Étienne Jodelle established tragedy with his *Cléopâtre* and comedy with his *Eugène*, both plays dating from 1552. These forms continued to develop with ROBERT GARNIER (1535-1601), Jacques Grévin (1540-70), and Jean de la Taille (1540-1608). The outstanding dramatic authors of the latter part of the century were Antoine de Montchrestien (1575-1621) in tragedy, and in comedy, Pierre Larivey (1540-1611), the latter being particularly influenced by the Italian comedy.

The 17th century witnessed the apogee of French drama. Jean de Mairet (1604-86), in his *Sophonisbe*, 1634, introduced the three unities into tragedy. The dominating figure of the early part of the century was PIERRE CORNEILLE (1606-84) whose *Le Cid*, 1636, *Horace*, 1640, *Cinna*, 1640, and *Polyeucte*, 1642, firmly established the tragedy in France. Later in the century JEAN RACINE (1639-99), with simpler plots, more natural dialogue, more poignant emotion, and a strict subordination of plot to character portrayal, brought the French tragedy to its acme of perfection. Representative of his work are *Andromaque*, 1667, *Bérénice*, 1670, and *Phèdre*, 1677.

In 17th century French comedy, Jean-Baptiste Poquelin (1622-73), known as MOLIERE, is preeminent. With unerring insight into human nature, he portrayed types true of all countries and of all generations, and produced humor through psychological evolution of character. Well-known among his plays, the universal appeal of which remains unquestioned, are *Les Précieuses ridicules*, 1657, *l'École des femmes*, 1662, *Le Misanthrope*, 1666, *l'Avare*, 1668, and *Tartuffe*, 1669.

In the early 18th century, Jean-François Regnard (1655-1709) and Florent Carton Dancourt (1661-1725) continued writing in imitation of Molière. Alain-René Le Sage (1668-1747), with his *Turcaret*, 1709, produced an outstanding comedy of manners, and Pierre de Marivaux (1688-1763), in *Le Jeu de l'amour et du hasard*, 1730, and many other plays, wrote exquisite, ethereal comedies of exceptional grace

and delicacy which reveal the author as a psychologist of love who excelled in the analysis of the feminine mind. In the works of Philippe-Néricault Destouches (1680-1754), Alexis Piron (1689-1773), Jean-Baptiste Gresset (1709-77), and particularly Nivelle de la Chaussée (1692-1754), a definite trend toward the *comédie larmoyante* (tearful comedy) is noticeable. In somewhat similar vein DENIS DIDEROT (1713-84) later attempted to establish the *drame bourgeois*, and definitely developed dramatic theories which are premonitory of the social drama of the 19th century. Independent of these men, PIERRE AUGUSTIN CARON DE BEAUMARCHAIS (1732-99), produced *Le Barbier de Séville*, 1775, and *Le Mariage de Figaro*, 1784, masterpieces of the comedy of manners in the brightness and rapidity of style and plot and the boldness of their ridicule of social abuses.

The tragedy of the 18th century is represented by PROSPER JOLYOT DE CRÉBILLON (1674-1762), author of romantic, lurid melodramas, and VOLTAIRE (1694-1778), who attempted to introduce modern subject matter into the dying French tragedy.

ROMANTICISM exerted a brief but powerful influence upon the theater of the early 19th century. ALEXANDRE DUMAS PÈRE (1803-70) held theater audiences spellbound with the vertiginous action of plays such as *Henri III et sa cour*, 1829, and *La Tour de Nesle*, 1832, and VICTOR HUGO (1802-85) stirred the hearts of the public with the lyric beauty of *Hernani*, 1830, which sounded the death knell of CLASSICISM. Between 1811 and 1861, EUGÈNE SCRIBE (1791-1861) wrote an enormous number of comedies containing little thought, poetry, or style, but remarkable for skilful combination of scenes. A master of stage devices and theatrical technique, Scribe, in his "well-made plays," strongly affected later French drama. Under the constitutional monarchy and during the Second Empire, the social dramas of Émile Augier (1820-89), and ALEXANDRE DUMAS FILS (1824-95), realistic in tone and content, replaced the earlier Romantic drama. Dumas fils is known particularly for his development of the thesis drama, and his theories influenced the French theater for a considerable time, traces of his influence being clearly discernible in the works of Paul Hervieu (1857-1915), François de Curel (1854-1928), and Eugène Brieux. Henri Becque (1837-99), an independent, is perhaps the most thoroughly realistic dramatist of that period. At the close of the 19th century, and in the early years of the 20th century, the Naturalistic School, dominated by ÉMILE ZOLA (1840-1902), achieved considerable notoriety. The drama of the time was considerably influenced by the development of Antoine's *Théâtre Libre* (1887-96) which, although not committed to Naturalism, produced many plays of that school. Two forces rose in opposition to Naturalism: the Neo-Romantic theater, represented by EDMOND ROSTAND (1868-1918), author of *CYRANO DE BERGERAC*, 1897, and the Symbolistic theater, representative of which are *l'Intruse*, 1890, and *Pelléas et Mélisande*, 1892, by MAURICE MAETERLINCK (1862-).

Concurrent with these various movements, but independent of them, the plays of Victorien Sardou (1831-1908), notable for their rapidity of action, lucidity, clever construction, and magnificent stage effects, enjoyed considerable popularity both in France and abroad.

Among contemporary dramatists, Paul Raynal may be mentioned as the most prominent war dramatist; Jean-Jacques Bernard offers interesting experiments in the "silent drama"; H. R. Lenormand has made efforts to renovate the psychological theater by the introduction of Freudian psychology and by stressing the importance of the subconscious; Jules Romains directs his comic shafts against the professions; and Jean Sarment resuscitates the fanciful, sentimental love psychology of Alfred de Musset. H. S. S.

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FRENCH EQUATORIAL AFRICA, the French Congo, a government-general of France on the west coast of Africa between the South Atlantic Ocean, the Cameroons and the Belgian Congo. They include the Gabun colony, through the acquisition of which French interest began in 1841; the Middle Congo colony; the Ubangi-Shari colony; and the southern portion of the Chad military territories, together with the mandated portion of Cameroons. An area of 107,207 sq. mi. was ceded to Germany in 1911 and added to German Cameroons; by the treaty of Versailles this was returned to France and is incorporated in French Equatorial Africa. The total area of the region is 912,049 sq. mi. and the population in 1926, 3,127,707, including only about 2,500 Europeans.

The coastal area is characterized by surf, sand bars and mangrove swamps, but there are a few useful inlets. The greatest development is found here. The principal exports are palm oil and palm kernels, rubber, copal and some coffee. Cattle, sheep, camels and ostriches are reared in the Chad territories.

The headquarters of the governor-general are at Brazzaville, on the Congo. Fort Lamy is the administrative center of the Chad territories, and Banghi, on the Ubangi, is the capital of the Ubangi-Shari colony. Libreville, capital of Gabun, enjoys relatively good shipping facilities.

FRENCH GUIANA, a colony lying at the northeastern extremity of South America, bounded on the north by the Atlantic Ocean, on the south and east by Brazil and by Dutch Guiana on the west. Area 34,740 sq. mi. The capital, CAYENNE, has a mixed population of 13,936, and about 6,000 in its penal settlement for habitual criminals sent from France.

Of the Guianas, the French colony displays a noteworthy lack of agricultural activity. Some 8,000 or 9,000 acres produce small quantities of crops destined almost wholly to domestic consumption. The most important export is gold, which accounts for

half or more of the value of shipments from Cayenne. Production is largely on a small scale in scattered fields, but output is more than twice as great as that of British and Dutch Guiana combined. The forests yield the second industry based chiefly on rosewood essence and balata, the two products in some years exceeding gold exports in value. The freeing of slaves in 1849 caused a labor crisis which has persisted in varying intensity to the present. Although various sources have been tapped, importation of labor has proved of little avail. The presence of a penal settlement greatly accounts for the lack of voluntary development from France. Pop. 1926, 47,340. See DEVIL'S ISLAND.

History. The French established a colony as early as 1604 in what is now British Guiana, naming it Cayenne, but it did not flourish. In 1626 the French settled on the Sinnamary River. During the next 50 years private companies tried to colonize the region, but were generally unsuccessful. Accordingly, in 1674 French Guiana passed to the crown. Although Colbert was the director of colonial attempts at the time, further efforts to develop the French interest in Guiana were of little avail. In 1763 private concessionaires shipped 12,000 colonists from Alsace and Lorraine to the tract between the Kourou and Maroni Rivers, where, because of inadequate provisions, all but 1,000 of them died in the next two years. In 1809 the British and Portuguese took French Guiana, but relinquished it by the peace of 1814-18, which ended the Napoleonic wars. The abolition of servile labor in 1849 gave the colony a setback, as it caused a severe shortage of labor, and an attempt to form colonies of free negroes from Africa met with little success. In 1852 the French established a penal settlement which also affected the desirability of the country for colonists. In its later history the colony became little else than a mere base of internment for state prisoners.

FRENCH GUINEA, a French colony on the west coast of Africa, between Portuguese Guinea and Sierra Leone, stretching along the Atlantic from 10° 50' to 9° 2' N. lat. The area is 89,436 sq. mi., and the population in 1929, 2,220,267, including 1,496 Europeans, of whom 1,389 were French.

The heavy summer rainfall of the coastal districts is responsible for much forest growth; rubber and palm trees, the latter important for kernels and oil, flourish in this area. There are plantations of rice, bananas, pineapples, coffee and cotton. The plains of the interior send peanuts, hides and beeswax to the coast for export. Some alluvial gold is found.

Konakri, or Conakry, the capital and an important modern town, situated on one of the Los Islands, has a long jetty and is connected by road and railway with the mainland. The colony is administered by the representative of the governor-general of French West Africa.

FRENCH HORN, a musical wind instrument belonging to the brass section of the ORCHESTRA; see also HORN.

FRENCH LANGUAGE, a very important ROMANCE language, conventionally divided into the three periods of Old (842 to about 1300), Middle (c. 1300-1550), and Modern (after 1500, and especially after 1636). Its first consecutive text is one of the versions of the Oaths of Strasbourg, 842, where the Latin word-order is still preserved, as well as the system of declensions characteristic of the language until the 14th century, but where the phonetic changes are far from complete. Old French is characterized by extreme diphthongization, e.g., Classical Latin *pīra*=VULGAR LATIN *pera*=Old French *pēire*, *pōire*, "pear" (every letter pronounced); and simple intervocalic dentals and gutturals disappear, as Latin *aqua*=French *eau*, "water." The three declensions of Vulgar Latin remain, e.g., second declension singular subjective *li murs* "the wall," objective *le mur*; plural subjective *li mur*, objective *les murs*; and since case-endings are thus retained, the word-order is not necessarily fixed. The conjugation of the verb is in conformity with the normal phonetic development, "love," etc., being *aim*, *aimes*, *aime(t)*, *amons*, *amez*, *aiment* (often with no subject expressed), traces of this still being seen in so-called irregular verbs like *je tiens*, *nous tenons*, "I hold, we hold."

With the 14th century the declensions disappear, and the objective case alone usually survives, while the diphthongs and triphthongs are reduced. By 1550 the modern pronunciation is achieved, this state being marked by the lack of real diphthongs, e.g., *eu* is pronounced much like German *ö* rather than as *e* plus *u*, by an even flow of speech with little accentuation, and by a complex vocalization, French having more vowel-sounds than any other of the principal West-European languages. H. F. M.

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FRENCH LAW is based chiefly on the Roman law but in part also in the germanic customary law of the north of France. In the fifth century, the Germanic tribes overran France and set up their own laws and customs. But much of the Roman law persisted and the Roman law was received through the Universities after the twelfth century. In 1804 a civil code containing 2281 articles was promulgated under Napoleon. Four more codes were added in 1807-08 and 1811. These five codes, modified and supplemented with other laws are the authoritative form of the law. But they are supplemented by reported decisions of the courts and doctrinal treatises. The French Civil Code has been copied very generally in all parts of the world except where English law obtains.

FRENCH LITERATURE. The French language is derived from Latin, the process being so gradual that it is impossible to declare when Latin, especially popular or "vulgar" Latin, ended and French began. Moreover, during the transition centuries so low was

the intellectual standard that there are scarcely any literary monuments. In fact, it is only in 843 that what is often called the first document in French literature appears. This is the *Oaths of Strasbourg* (really bilingual, as one of the forms is Teutonic), declaring the alliance of two grandsons of Charlemagne against a third brother. The document has nothing to do with literature, and the average modern Frenchman would be totally unable to understand it.

Middle Ages. In this period the language spoken in the territory now occupied by the French nation became differentiated into a number of separate neo-Latin tongues, just as to-day on a larger scale, French is distinguished from Italian or Spanish, though all are neo-Latin. In what now constitutes France there grew up two large groups of dialects: a northern, designated *langue d'oïl*, and a southern, the *langue d'oc*, each so called because of the distinctive forms of the modern word *oui* in the north and south. In time, owing to the growing power of the king, the language of the Ile de France, the royal domain, acquired supremacy over the other dialects and gradually became the national idiom. For many generations during the Middle Ages, however, dialects such as Norman and Picard, to mention only two, had important literary manifestations, still valuable to the student of Old French. In the *langue d'oc*, the various forms of Provençal produced the rich literature of the troubadours, but grew so far away from French as to be really another language.

It must not be forgotten that during all the Middle Ages and even through part of the Renaissance the language of learning and scholarship was a continuation of literary Latin. The Old French literature studied to-day was largely a popular production intended for the delectation as much as for the instruction of the non-scholarly, from the aristocracy down to the peasantry. Because so few could read, wandering minstrels and reciters, sometimes authors of their compositions, such as the *trouvères* and *jongleurs*, played an important rôle in transmitting the text to their audiences.

According to its predominant appeal, a medieval work may usually be roughly classified as either courtly and chivalric for the higher ranks, the feudal aristocracy, or popular for the bourgeoisie and the lower classes. Generally speaking, the themes corresponded to the tastes of those for whom they were destined; the favorite form was verse.

Among the courtly works, the heroic epics, or *chansons de geste*, were preëminent in renown and influence both at home and throughout Europe. These poems dealt fancifully, though often upon a foundation of fact, with the achievements of Charlemagne and great feudal warriors and vassals. It is now thought that the *chansons*, though probably based on remote popular ballads, were composed by individual authors for the edification of travelers and pilgrims, in connection with monasteries and similar establishments on the highways to great fairs and

pilgrimage resorts. The masterpiece of this literature is the *Chanson de Roland* of the 11th century. Even more courtly in tone, and probably more likely to be actually read, were the epic romances dealing with love and adventure and centering chiefly round King Arthur and the Knights of the Round Table. The chief writer was CHRÉTIEN DE TROYES, of the 12th century. Finally, the poems of the so-called cycle of antiquity, of which the most noteworthy dealt with Alexander the Great, unconsciously revealed the ignorance of ancient civilization prevailing in medieval times. In prose the outstanding writings were those of the historical chroniclers, extending almost to the Renaissance: Villehardouin (of the 12th century), historian of the Crusades; Joinville (13th century), biographer of St. Louis; Froissart (14th century), narrator of the wars of feudal chivalry; and Commynes (15th century), recorder of political intrigue in the age of Louis XI.

The verse-literature favored by the bourgeoisie and the people tended towards realism and satire. The *fabliaux*, or *fabliaux*, as they are more generally called, were short stories, mostly humorous, ridiculing the defects of various classes and types, and highly disrespectful to women and the petty clergy. The huge *Roman de Renard* of the 12th and 13th centuries, in many "branches," is on the one hand associated with fable themes, and on the other it has the appearance of a satirical beast epic, centering about the crafty figure of Renard as the embodiment of guile and treachery.

Three other flourishing literary forms must be mentioned: lyric poetry, didactic poetry and the drama. Early French lyricism was both popular in the form, for instance, of simple love songs, and sophisticated through the influence of the more complicated and artful poetry of the southern troubadours. The lyricism of Ruteboeuf, of the 13th century, was satirical. As the centuries proceeded, lyrical poetry became increasingly conventional in its complicated metrical structures until the verse-carpentering of the Great Rhetoricians occurred at the end of the 15th and the beginning of the 16th century. Two very great poets, however, belong to the 15th century: Charles d'Orléans and FRANÇOIS VILLON. Charles was the embodiment of graceful poetic epicureanism. Villon, vagabond and consort of criminals, has been called the first modern poet because of the vigor of his lyrical personality and his insistence on the deep and tragic themes of human experience, especially death. Didactic poetry was plentifully interwoven with the allegory which flourished so luxuriantly in the Middle Ages. The whole spirit of such literature is summed up in the *Romance of the Rose*, begun as a love allegory in the early 13th century by Guillaume de Lorris. The unfinished poem of 4,000 lines was carried to completion half a century later by JEAN DE MEUNG, who transformed it into a strong satire of current moral and social themes from the point of view of a bourgeois realist and a foe to idealism.

The drama was a highly favored form. In its serious aspect it was the outgrowth of the church mass, into which dramatized dialogues were on certain festivals early introduced. The liturgical drama, transferred from the interior of the church to the open space outside, developed into the great cycles of mystery plays, for the most part still religious in theme, but becoming examples of community drama on a large scale. In comedy, the farce, linked by its themes to the *fabliau*, was highly popular and has lasted in spirit to the farce of the modern French stage. Other vigorous types were too intrinsically medieval to survive the period. Such were the morality play, in which abstract allegorical figures appeared as characters, and the *sottie*, in which the emphasis was placed on political rather than moral allegory, and which dealt with contemporary events.

The Renaissance. By the 16th century, the effect of the revival of learning and of the Renaissance in Italy was felt in France. It was formerly believed that intellectually the French Renaissance was widely separated from the Middle Ages. Now opinion holds that the Renaissance merely brought new discipline and new literary material without changing the national spirit. In any case, the reign of Francis I (1515-47) saw the development of the great movements of Humanism, the Renaissance and the Reformation. All were phases of the great revolution against the traditional medieval dogmatism and yielding to authority, stimulated by new discoveries, scientific, mechanical and geographical, which made people revise their old idea of a static universe. The invention of printing especially contributed immeasurably to independent thinking and judgment. The three movements enumerated above were sometimes interwoven, sometimes in conflict, but Humanism and the Renaissance were likely to be so closely associated that the former is often considered a first stage of the latter. Humanism was an appreciative yet often preponderantly scholarly love of classical literature. The Renaissance suggests an even greater assimilation of the spirit of antiquity and an endeavor, not always successful, to renew its intellectual philosophies, moral theories and literary types. The Reformation, seeking to revive the teachings of primitive Christianity, and akin in aim to Humanism, soon diverged from the neo-paganism, particularly the hedonism, into which the sensuous enjoyment of life led the new civilization's literature and art. Calvin, in particular, declared that human nature was not good but corrupt, and built up his great church on the religious doctrine of original sin. On the other hand, one sees in Rabelais, a popularizer of the erudition of the humanists, an immense gusto in living. In the form of fiction, his writings taught that human nature is good and that the minds of well-born men and women, if subjected to gracious influence in art and letters, will incline to virtue rather than to vice. CLEMENT MAROT is the outstanding poet of the reign of Francis I, but he showed neither supreme genius nor the strength to make his inclinations toward the

reformed religion victorious over a weak will and a sensuous nature. But he helped to effect the transition from the mechanical verse of the Rhetoricians to the true lyricism of the Renaissance.

The great poetic school known as the *Pléiade*, led by PIERRE DE RONSARD and JOACHIM DU BELLAY, exemplifies the full development of the French Renaissance and the effort of genuine poets, schooled in the Humanism of France and Italy, to assimilate and reproduce the spirit of antiquity. Ronsard, in particular, stressed the power of Hellenism. The *Pléiade* produced a rich harvest of personal poetry, particularly sonnets, and cultivated anew such ancient forms as the drama, eclogue and epic. Unfortunately, enthusiasm often outstripped discretion. The choice of models was sometimes injudicious and reckless. When the stimulus of Ronsard was gone, French poets frittered away their efforts in imitation of florid second-rate lyrists of the late Italian Renaissance. But, in prose, the essays of MICHEL DE MONTAIGNE, which were penetrating studies of moral psychology based on personal experience and meditative contact with ancient writers, profoundly deepened man's knowledge of himself.

The 17th Century. At the beginning of this period people liked to feed their fancy. They enjoyed interminable sentimental romances, scintillating society verse, plays which led the mind to wander through imagined scenes of idyllic pastoral life and dashing dramas of love and adventure wherein Spanish influences played considerable part. PIERRE CORNEILLE, one of the greatest dramatists of France, developed in his historical plays conflicts between the emotions and between honor and duty, in which the strong will emerged supremely victorious. But Corneille was not the full Classicist because his characters lacked the true complexity of human nature. Certain great prose writers did as much or more to deepen French literature. The technical philosopher RENÉ DESCARTES, stimulated the movement for order and method in critical exposition as well as in metaphysical reflection. PASCAL, philosopher, physicist, mathematician and theologian, in a prose at times of biting sarcasm, at times of profound poetic beauty, made men down an opponent in argument or reflect on the wonderful mysteries of the world and the hereafter.

The greatest period of French Classical literature was the second half of the century. The qualities prized were those expressive of clear, orderly, logical minds. "Reason" was the deity of men of letters, and truthfulness rather than fantasy was the constant aim. As a result, lyrical and personal poetry dropped to a secondary position, and the drama, dealing with universal, or at any rate, general traits of human nature, was more in favor. Tragedy tried to be truthful, plausible, or realistic in a sense higher than the modern one. This was what the catchword of criticism, *vraisemblance*, implied; the insistence on the three famous unities of time, place and action indicates an effort to achieve this end. At-

tention thus centered on human nature encouraged prose forms like the moral maxim or the character study, as well as comedy in verse and prose, in which average human nature is analyzed and portrayed from the point of view of common sense. Consequently, no century in French literature has produced in such a short time so many writers of genius or of great talent who, under the patronage of a monarch encouraging literature to increase his own glory, brought forth noteworthy interpretations of the spirit of the age. RACINE portrayed (under names borrowed from antiquity) passionate women, modern in spirit, yielding to crime. MOLIERE poured ridicule on the follies of the men he saw about him: hypocrites, social climbers, pedants, profligates and many others. LA FONTAINE, in his fables, satirized his contemporaries under animal disguise. BOILEAU, in his satires, was more outspoken and personal, and in his *Art of Poetry* upheld rigid standards of neo-classical theory; LA BRUYERE, in his *Characters*, sketched the types of his day; La Rouchefoucauld did the same in the more concise form of cynical MAXIMS; MME. DE SÉVIGNÉ in her immortal correspondence gossiped about everyday matters. Meanwhile, among the great pulpit orators, Bossuet showed how the great lessons of Providence are illustrated in the ways of men. Bourdaloue wished to reform morals by his eloquent sermons, and Fénelon tried to make religious thought, imaginative prose, literary criticism and educational theories less rigid and more helpful to the individual.

The 18th Century. Classicism was static: it was assumed that civilization had reached its climax under Louis XIV. The trend of the 18th century was different and was partly the result of the rationalistic philosophy of Descartes. Cartesianism outgrew classicism. Instead of seeing perfection in ancient classical ages, it emphasized the power of reason to advance and improve. The Golden Age was no longer in the past but in the indefinite future. In literary theory an important early manifestation of the divergence is seen in the quarrel of the ancients and moderns, with Boileau leading the conservatives and Perrault the innovators. The new tendencies now became predominant. It is true that in literary and aesthetic criticism and in tragedy a form of Classicism continued to hold sway, but it became more mechanical and bound by rules. In other fields, however, thought was more venturesome. Instead of confining themselves to the moral analysis of human nature, men cultivated the rational sciences and tried to apply mathematical, or at any rate logical methods to economic as well as moral problems. Religious dogma did not escape scrutiny, and Bayle paved the way not only for tolerance but also for unbelief. In coffee-houses, in printed journals and in *salons*, where clever women entertained their friends, the *philosophes* expounded their views. *Philosophe* was loosely applied to designate those who theorized over all the new problems. Some were mathematicians, others moralists or economists, some

merely pamphleteers and journalists. But a common feeling led them from religious idealism to materialism, or at least to a vague religiosity, hostile to dogmatic faith, called natural religion and deism.

Among the influential literary and intellectual figures of the period, though all do not come under the general designation of *philosophes*, one must not forget MONTESQUIEU, so significant in the philosophy of history and constitutional government; VOLTAIRE, the cynic and enemy of religious dogma and reverence, a destructive force; and JEAN JACQUES ROUSSEAU, the creator of so many immature theories which have since been developed into ideas that rule the world. DIDEROT, with his extraordinary power of intellectual synthesis, was the editor of the great *Encyclopaedia*, in which all the knowledge of the 18th century was classified and interpreted in harmony with the ideas of the *philosophes*.

Rousseau marks the transition from a literature of reason to one of sentiment and emotion. Through his influence, the personal note became stronger, the literary hero magnified his sufferings and saw in the outer world the reflection of his "sensitivity." Tearfulness became the order of the day and the unrestrained outpouring of feeling was confused with virtue. By the early 19th century, the influence of Rousseau in France, encouraged by cosmopolitan influences such as English 18th-century meditative melancholy and German sentimentalism, and intensified by the horrors of the Revolution and the wars of Napoleon, had developed into full-fledged Romanticism.

19th Century. Two very important names now appear: CHATEAUBRIAND and MME. DE STAËL. The former, sometimes called the Father of Romanticism, accentuated melancholy and magnified aesthetic and emotional, instead of intellectual, reactions. He contributed to Romanticism the *mal du siècle*, the morbid melancholy and diseased will from which the literary hero suffered. Mme. de Staël helped to discover German thought and to develop the type of the *femme incomprise*, a woman at war with her social environment, whose hopes and happiness were ever thwarted.

The first half of the century is of extraordinary interest. It saw the enunciations of new religions and new philosophies, the proclamation of new schemes for regenerating society and liberalizing political life. Finally, it produced a rich harvest of lyrics, fiction and imaginative drama. Victor Hugo, Alphonse de Lamartine, Alfred de Musset and Alfred de Vigny (see separate articles on these authors) are four of the very great poets of French literature. The vivid historical works of DUMAS PÈRE had a vigor and dash unsurpassed by those of Scott. GEORGE SAND, like Mme. de Staël, wrote of the misunderstood woman and created mystical and poetical social utopias.

But Romantic literature, rejecting the restraints and standards of reason and taste, was in time the victim of its own qualities. It had begun as a rebellion

against a devitalized Classicism and had declared itself a return to the emotions of real life. Yet before long the Romanticists were devising plots and characters wildly fantastic and psychologically impossible. Some writers, in spite of strong Romantic impulses, were wise enough to revert to a truer interpretation of human nature, and created the Realistic School. STENDHAL developed the psychological novel somewhat ahead of his age and only acquired full recognition half a century later. But HONORÉ DE BALZAC, in the numerous volumes of his huge *Comédie humaine*, created the counterpart of the society of his time with all its selfishness, petty intrigues and sordid adventures. FLAUBERT, with equally painstaking accuracy of transcription, reproduced all the minor details which build up the sum total of mediocre lives.

The anti-idealism of the Realistic School was accentuated by the materialism of the Second Empire. Outwardly there was great national prosperity, owing to Napoleon the Third's encouragement of public works, and France was considered the leading military power of Europe. Therefore, prose-writers became smart and cynical; and poetry, reacting against the exaggerations of Romanticism and the industrialism of a material age, took refuge in objective perfection of finish and in the cult of "art for art's sake." The development of scientific thought and the rise of doctrines of evolution had their counterpart in the critical theories of men like SAINTE-BEUVE, to whom literary criticism was the "natural history of human minds," and TAINÉ, who interpreted all intellects as determined by the mechanical factors of time, race and environment.

The downfall of the Second Empire and the humiliating defeat of France by Prussia swept discouragement over the land. Literature became even more cynical and pessimistic. Two thinkers exerted great influence and inspired two literary schools which, however, exaggerated and caricatured their teachings. One was Taine, already mentioned, whose disciples in historical investigation, aesthetic criticism or pure letters emphasized the determinism of science. The other, ERNEST RÉNAN, incarnation of brilliant intellectualism and detached irony, unwittingly fostered in more superficial followers an attitude of irresponsible disillusion towards life and a dilettante impressionism dangerous by its corroding smartness. In prose fiction the influence of Taine showed itself in the extreme form of realism called Naturalism. Before the end of the Second Empire the Goncourt brothers had prided themselves on analyzing the morbid manifestations of a neurotic modern civilization, but Taine's more direct follower, ÉMILE ZOLA, described with tedious prolixity the sordid and repulsive aspects of life. Just as the Romanticists had gone astray in quest of the fantastically exceptional, so the Naturalists tried to whet the appetites of readers jaded by the drab monotony of realism, by dwelling upon the abnormal and the pathological. Similarly the drama, especially comedy, had evolved

from the old bourgeois realism of ÉMILE AUGIER, through the worldly cynicism and then the rather hysterical preaching of the plays of ALEXANDRE DUMAS FILS to the raw crudities of the *Théâtre libre*. Concurrently, the literary disciples of Renan adopted in criticism a tone of smart and flippant paradox. Moreover, just as the generation which had grown to manhood after the Revolution and the wars of Napoleon had been a victim of the pessimism of the Romantic School, so the generation born in privation during the "terrible year" of the Prussian invasion reached its majority steeped in disillusionment. It is no wonder that, through a fallacy of the imagination, the end of the 19th century seemed to imply the end of an era of civilization. The terms *décadent* and *fin-de-siècle* were applied to literature and art, and many poets deliberately rejected the traditional French clarity and sought to conceal their ideas behind a veil of symbolism. Finally, a great national crisis divided France into two great hostile parties at variance over the guilt or innocence of a Jewish army captain, ALFRED DREYFUS, accused of betraying military secrets to Germany. The immediate results of the Dreyfus affair satisfied nobody because the victim was twice convicted by court-martials and then pardoned by the government.

20th Century. The beginning of this century saw French literature thoroughly disorganized, as compared with the discipline of seventeenth-century Classicism, or even the cohesion in literary principles of the Romanticists in their hostility to the Classical School. Much was contributed to this disorganization by Bergsonism, the philosophy of HENRI BERGSON, which, as a revolt against the scientific intellectualism of the 19th century, accused of having failed to fulfill all its proud boasts, now sought to unite life and matter in a single synthesis, a "creative evolution," abolishing the old dualisms which had long dominated thought. The flexibility and indeterminism of such a system coincides with the downfall of literary and artistic types, or *genres*, and with the disappearance of fixed conventions of taste and rules of art, such as had existed, if not during the days of Romanticism, at any rate during the whole Classical dispensation which had been preserved in the standard French academic criticism. The new literature was, indeed, a pronounced form of neo-Romanticism. Therefore, when France became involved in the World War, though the dissensions of the Dreyfus period were now over and the country met its enemy with a unified spirit of ardent patriotism, the literary world had become subdivided into a large number of divergent sects. Nor has the postwar period resulted in a greater unity. C. H. C. W.

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FRENCH REVOLUTION, THE, 1789-99, was an attempt to effect reforms long deferred and badly

needed. The Old Régime destroyed itself by its own incompetence. The peasantry and the urban workers suffered from their many archaic economic and political disabilities, while the business needs and political demands of the new class of wealthy bourgeois found only a narrow outlet under the existing Government institutions and social classifications. Two generations of gifted publicists had directed a devastating fire of criticism against the Bourbon monarchy (see *BOURBON HOUSE*), discrediting old ideas and institutions and indoctrinating the middle classes with new ideas for bringing to the greatest number the maximum of happiness that this world reserved for man. These new ideas revolved around the principles of civil liberty and constitutional self-government. While circumstances and speculation prepared the Revolution in France, the example of the American Revolution confirmed it in advance. It justified by anticipation the attitude that the bourgeoisie was to take in 1789 when the King summoned the Estates General and appealed to the middle classes for their counsel and support. The Revolution came in 1789 because a many-sided crisis of gravest proportions held all the land in its grip, serving like a catalytic agent to precipitate from solution all those potent elements of reform that had been seething in the cauldron of discontent.

The summer of 1789 passed in a dramatic struggle between the forces of reform and reaction. By their defiance of Louis XVI the deputies of the Third Estate transformed the Estates General into a National Constituent Assembly that was pledged to give France a constitution. Twice violent uprisings of the revolutionary populace of Paris answered the armed intimidations of the monarchy against the policy of reform. On July 14 a mob fell upon the Bastille, and early in October popular agitators led a hungry, turbulent procession to Versailles, bringing back in triumph to Paris the royal family and the revolutionary assembly. During that hectic summer of 1789 the middle classes began the demolition of the Old Régime. In the towns they established communes and seized the reins of municipal Government. They formed bourgeois national guards for the defense of property and the preservation of law and order. Under the pressure of the rioting of the rural proletariat the deputies quickened their course, decreeing, in principle, the abolition of the feudal system (see *FEUDALISM*) and the extinction of all social and political privileges based upon birth and caste.

Reforms of the Constituent Assembly. In October the Constituent Assembly settled down in earnest to its arduous task of reconstruction. The bitter skirmishes of the summer had cleared the political atmosphere. To use an anachronism, the deputies were grouped in the three large divisions of the Right, the Center, and the Left. The conservative deputies of the clergy and the nobility who sat to the right of the presiding officer's chair echoed the views of those Frenchmen who completely opposed reform. The more moderate deputies who sat in the benches of the center were the apostles of the

English Parliamentary system. Among the great mass of deputies who sat on the left were the firm but variously minded champions of reform. These included the pock-marked, volcanic Mirabeau, the learned Bailly, the high-minded Barnave, the owlish Abbé Siéyès, and the ambitious Robespierre. Each of these groups had, outside of the assembly, its many supporters, its press and its clubs. But the revolutionary forces were the most numerous, their journals the most widely read, and their organization, particularly that of the affiliated Jacob (*see* JACOBINS) clubs and the federated national guards, the most militant and effective.

For two years the deputies persevered in their gigantic task of establishing new institutions. They drafted the Declaration of the Rights of Man and the Citizen to guarantee the natural, inalienable and imprescriptible rights of the individual. They drew up a constitution and made provision for a unicameral legislature resting on a broad, though not universal, suffrage. They reformed the local administration, abolishing the historic provinces and establishing departments, and they simplified and corrected the abuses of the judicial system. These reforms did not pass unchallenged; but the fiercest resistance came to their financial and religious policy and to their measures concerning the abolition of the feudal system. When they finished their labor, the legalized inequality of the Old Régime had disappeared forever, and a constitutional monarchy largely for the benefit of the propertied middle classes had come into being. But the new régime was attacked, not only by the comparatively few obstinate reactionaries, but by millions of humble souls who held no brief for the ancient abuses. These opposed it for various reasons, some for the subjection of the Church and the sequestration of ecclesiastical property; some for its compromise solution of the problem of feudal dues; others for its inability to check inflation and restore financial stability; and many for its undemocratic political structure. The deputies of the Left were, themselves, divided in their views. The majority, led first by Mirabeau and later by Barnave, desired to consolidate the gains already made, while a small minority, led by Robespierre and supported outside of the assembly by the aggrieved peasants and city workers, wished to effect more radical reforms.

Monarchy Abolished. Thoroughly out of sympathy with the revolutionary course, the King fled from Paris to gather forces against the leaders, but he was stopped en route to the eastern frontier and brought back, virtually a prisoner, to the capital. He gave his signature to a revised constitution; but those who thought that the Revolution was ended were grievously mistaken, for a swift tide of economic and political protest against the constitutional monarchy was sweeping its way across the country. Under the leadership of the shallow journalist, Bissot, the Girondin deputies of the Legislative Assembly, Oct. 1, 1791-Sept. 19, 1792, provoked a war with Austria. First, reverses on the front and later, the in-

vasion of the country by the Austrian and Prussian troops terrified the "patriots," while the new popular leaders of the masses whipped patriotic fears and local grievances into a frenzy of indignation against the suspected treason of the king. On Aug. 10, 1792, the extremists of Paris and the federated national guards then in the capital carried the royal palace by storm, while three weeks later an unleashed mob made a hideous massacre of imprisoned political suspects. Louis XVI was suspended from office and imprisoned, the Girondins being helpless before the revolutionary Commune of Paris. To effect the legal overthrow of the monarchy elections for a new assembly were held on the basis of universal manhood suffrage.

The National Convention, 1792-95, immediately made a momentous change: it abolished the millennial monarchy and established a republic, "one and indivisible." Its internal history revolved, until June 1793, around the struggle between its two foremost political factions, the GIRONDINS and the Jacobins. The personal rivalries of the leaders and the sharp differences in social and economic views generated, on either side, sweeping accusations which in those troubled days seemed plausible, but which in the light of perspective are found to be groundless. The Girondins steadily gave ground to their rivals, being weakened in general by their political ineptitude and in particular by their ambiguous rôle in the trial and execution of Louis XVI and by the desertion of Gen. Dumouriez and the collapse of the second French offensive. Sentiment turned against them, and a popular insurrection resulted in the arrest of their leaders, the suspension of the others from the Convention, and the uncontested supremacy of the Jacobins in the assembly.

Under the Convention. The political unification of the Convention came none too soon, for the country was on the verge of dissolution. In the Vendée the Royal Catholic Army was driving back the republican defenders. On the eastern frontier the forces of the First Coalition of European Powers, established under England's leadership in consequence of the French revolutionary propaganda and policy of annexation, thundered at the barrier fortresses. Within France the demoralization of economic activities was complete, rising prices and scarcity of food supplies provoking rioting and pillaging and hostile political demonstrations. To add to the misfortunes the Girondin leaders escaped from Paris and fled to the departments to organize a rebellion against the Convention. The Convention was equal to the emergency. Against its various enemies within and without it invoked the Terror, fighting violence with fire. The Committee of Public Safety, functioning like a war-time dictatorial cabinet, directed all the activities of the central Government and its local agents. The country became an armed camp. The committee and its agents tapped all the human and material resources of the land. Soldiers were enrolled, hastily trained and equipped, and rushed to the points of danger. The "sacred guillotine," working relentlessly, struck at all

dissenters, ruthlessly suppressing opposition to the Government. The results of this stupendous national effort were electrifying. By the end of 1793 the Convention had crushed the internal forces. The foreign foe were driven back and the victorious republican troops swept on to conquer France's "natural boundaries" of the Rhine and the Alps.

Withal, the deputies found time to continue their reforms. They established a new revolutionary calendar which abolished the Sabbath and the saints' days and, as a substitute for Christianity, they organized the revolutionary religion of patriotism. They introduced the scientific metric and decimal systems and they considered various drafts of a national code of civil laws. They discussed several projects for the reform of the educational system and they made an attempt to replace local dialects with the French language in all parts of the country. They completed the abolition of the feudal system.

Month by month Robespierre, "the Incorruptible," and his little coterie of followers increased their domination over the deputies of the Convention and their control in the Committee of Public Safety. One by one his rivals to power were removed from his path. Marat was assassinated. Hébert was guillotined for his mad attempt to establish the worship of reason while Danton and his friend, sick of the excesses of the Terror, incurred the hostility of Robespierre and were also executed. In the spring of 1794 Robespierre's ascendancy was complete, and from that date began the second and last phase of the Terror. In the hands of the fanatical idealists in control of the Government the Terror became the instrument of social and economic reform, the reform which was to usher in the Republic of Virtue. Robespierre and his two leading associates, Saint-Just and Couthon, abused their opportunity and failed dismally in their avowed program. Their homicidal idealism aroused only loathing and dread among the people, sentiments which a sorry group of political opportunists utilized on the 9 Thermidor, year II, July 27, 1794, to overthrow the Robespierrists.

The Directory. Immediately after Robespierre's death there was a violent reaction against the surviving terrorists and the institutions of the Terror Government. This reaction, in turn, provoked counter-demonstrations and two popular insurrections in Paris against the Thermidorean Convention. The Convention was dissolved in Oct. 1795, having devised, shortly before its dissolution, a new constitution, which was ingeniously constructed to hold both radicals and reactionaries in check and make the republic safe for the conservative middle classes. In the new Government, 1795-99, the executive power was wielded by the Directory of five members, and the legislative power was exercised by the Council of Ancients and the Council of Five Hundred.

The Government of the Directory was constantly exposed to the perils of a fresh radical revolution and a reactionary Bourbon restoration. The country longed for peace and stability, but too many interests

were involved in the liquidation of the Revolution to allow a peaceful reestablishment of equilibrium. The Government's efforts were unsuccessful, except in the operations of the war against the European Powers, where the genius of Bonaparte brought new victories to the French republic. The Directory survived as long as it did, because it employed the troops against its political opponents. When the soldiery under Bonaparte turned against it, it fell, Nov. 18-19, 1799, and upon that military adventurer devolved the responsibility for perpetuating the great accomplishments of the Revolution. L.G.

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FRENCH SOMALILAND, a territory formerly known as Obok, in eastern Africa, lying on the Strait of Bab-el-Mandeb and the Gulf of Aden. It is bounded on the west by Abyssinia, on the north by Eritrea and on the south by British Somaliland. The area is 5,790 sq. mi., with a population in 1928, estimated at 85,778, of native tribes, Arabs and Indians.

The territory has a hot and arid climate and vegetation varying in type from the semi-desert and savanna to forest growths of the warm temperate variety. The Hamitic tribes in this area are nomadic. With the exception of mined salt, there is little export of indigenous products. The fisheries have local importance.

Jibuti or Djibouti is the capital and an important port of call, chiefly for French ships. It holds a commanding position opposite Aden at the entrance of the Red Sea. In 1865 France purchased the port of Obok on the Gulf of Tajura, but effective occupation did not begin until 1882.

FRENCH SUDAN. See SUDAN.

FRENCHTOWN, BATTLE OF. See RAISIN RIVER, BATTLE OF.

FRENCH WEST AFRICA, a government-general of France comprising the colonies of Senegal, French Guinea, the Ivory Coast, Dahomey, French Sudan, Upper Volta, Mauritania, Niger and Dakar with its dependencies. (See separate articles on these subjects.) The total area of this colonial territory, which takes up more than half of the entire northwestern bulge of the African continent, is 1,247,191 sq. mi. The population in 1926 was 13,541,611, only 15,400 of which were not natives. The whole territory is administered by a governor-general who devotes his entire time to the common interests of all the colonies. The various colonies are governed by lieutenant-governors who are directly responsible to the governor-general at Dakar, the capital city on the coast.

This vast region is for the most part a plateau country interrupted by ridges which rise from 2,000 to 6,000 ft. above sea level. It is traversed by some of the principal rivers of Africa, chief among them the NIGER and the SENEGAL. The Niger Colony, French Sudan and Mauretania merge into the Sahara

with its dry climate, and in April and May experience the harmattan, a red dust-laden wind rising in the interior. Further south there is a tropical climate with heavy rains.

The main products of French West Africa are vegetable oils, rubber, ivory, gum, timber, maize, millet, ground nuts, cotton and rice. Various fruits and vegetables are grown. There are no extensive industries. Leather goods and cotton stuffs are produced but are of little commercial value. The chief exports in 1928 were rubber, cotton, timber, cocoa, fruits and oil seeds. The total value for the year was 1,241,115,812 francs. The principal imports, representing, in the same year, a total value of 1,513,843,757 francs, were textiles, beverages, mechanical implements and food substances. Half the foreign trade was with France.

FRENEAU, PHILIP (1752-1823), American poet, was born in New York City, Jan. 2, 1752. He graduated from Princeton, where he lived with JAMES MADISON, in 1771. Nine years later he was captured at sea by the British, and relates his experiences in *The British Prison Ship*. During the Revolution he wrote much satirical verse directed against the Tories; he published his collected verse in 1786. As a lyric poet, who wrote of natural beauties with deep sympathy, he was a precursor of WILLIAM CULLEN BRYANT. Among the best known of his poems are *The Battle of Eutaw Springs*, *The Indian Burying Ground* and *The Wild Honey-Suckle*. Freneau died near Freehold, N.J., Dec. 18, 1823.

FRENSEN, GUSTAV (1863-), German writer, was born at Barlt, Oct. 19, 1863. He was pastor of a church at Hemme during the writing of his first novels. Frenssen belongs to the *Heimatkunst*, or regional literary movement in Germany, having depicted chiefly the simple life of the north German plains. Among his works of note are *Jörn Uhl*, 1901, *Hilligenlei*, 1905, and *Die Brüder*, 1918.

FREQUENCY, the number of complete cycles through which an ALTERNATING-CURRENT passes in one second. For electric power and lighting purposes a frequency of 60 cycles per sec. is in common use, although for special purposes both higher and lower frequencies are sometimes employed. In radio circuits carrier-wave frequencies of hundreds of thousands, or even millions, of cycles per sec. are common, and in short-wave transmission frequencies of a billion cycles per second are reached (see RADIO COMMUNICATION).

In radio work, frequencies are usually expressed in kilocycles, more properly, kilocycles per sec. A kilocycle is 1,000 cycles. Thus, a frequency of 1,000 kilocycles is 1,000,000 cycles per sec. Under the regulations of the Radio Commission, each broadcasting station is required to broadcast on a definite assigned WAVE-LENGTH, or frequency. Formerly, the wave-length specification was preferred; more recently, the frequency designation has become almost universal. The relation between these two specifications is very simple. The velocity with which a wave travels in

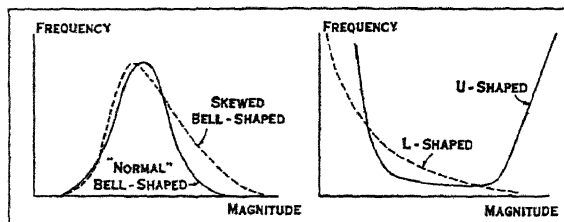
any medium is given by the product of the wave-length and the frequency. Hence, given the velocity of the ether wave, 300,000,000 m. per sec., the frequency corresponding to a given wave-length is found by dividing this number by the wave-length expressed in meters, or vice versa.

L. B. S.

FREQUENCY CHANGERS, in power, consist usually of a synchronous MOTOR-GENERATOR set, the number of poles on the two machines each being proportional to the FREQUENCY of its own respective system. The frequency changer may supply power to some isolated system, or it may be used to tie together two systems of different frequencies.

The term, *frequency changer*, is also applied to a device for altering the number of complete cycles per second of a radio wave. As ordinarily used in RADIO RECEIVER circuits, this term applies to the use of the non-linear characteristics of an electronic tube (see TUBES, ELECTRONIC) whereby the output circuit of such a tube may be made to contain the beat note between two other frequencies supplied to the tube. The oscillator (see OSCILLATOR, ELECTRIC) and first DETECTOR tubes of a SUPERHETERODYNE are sometimes called a frequency changer. A similar arrangement of tubes may be used to convert the frequency of a short-wave signal to one in the broadcast band (see RADIO COMMUNICATION), so that a broadcast receiver may be used for receiving short-wave signals. Long waves may be similarly converted.

FREQUENCY DISTRIBUTION, in statistics a factor arising from the classification of measured phenomena. The term may be explained as follows: When a large number of individual instances are measured for a given trait, such as height, they are found to range from a low value to a high value. If this range be broken up into segments, varying numbers of individuals fall within these several divisions. The divisions, measured from the lowest possible case that can fall within the division to the highest possible case, are called class intervals. The number of individuals falling within each class interval is called a frequency. The entire grouping of class intervals and frequencies therein is denoted a frequency distribution.



FREQUENCY DISTRIBUTION CURVES

Many types exist, those most commonly occurring being so-called normal or bell-shaped symmetrical, found in most physical and mental measurements such as height or intelligence; asymmetrical bell-shaped or skewed, descriptive of most weight or size-of-families series; L-shaped or decreasing returns, found in age

or income data; and the less common U-shaped distributions, as in certain climatological material.

Three forms of graphic portrayal of frequency distributions are in use—histograms, polygons, and curves. Several types of frequency curves are shown in the accompanying illustration. There are many measures descriptive of these distributions. Averages—arithmetic mean, median, mode, geometric mean, harmonic mean, and contra-harmonic mean; measures of variability—range, semi-interquartile range, average or mean deviation, probable and standard errors, coefficients of variation; and measures of skewness.

The term frequency distribution is usually confined to one variable. When classification is made according to two or more variables the distribution is called a correlation table and other measures are utilized, such as coefficients of correlation. See CORRELATION.

A FREQUENCY DISTRIBUTION OF AGES

AGES OF NATIVE WHITE MALES IN CONNECTICUT: 1920

(Compiled from Fourteenth Census of the United States, 1920, Vol. II, p. 199)

Years	Thousands of Persons
Under 9	48
10-19	37
20-29	36
30-39	31
40-49	26
50-59	19
60-69	14
70-79	8
80-89	2
	221

F. A. R.

FREQUENCY METERS, instruments for indicating directly the number of cycles which an ALTERNATING CURRENT makes per second. There are three main types, the reed, the inductance and the resonance. The reed frequency meter comprises a number of steel reeds, fixed at one end and free to vibrate at the other, and an ELECTROMAGNET connected to the current supply whose frequency is to be measured. The reeds have different natural periods of vibration and, being located in the field of the electromagnet, the one with the period corresponding to the alternations of the magnetic field will be set in vibration, thus indicating the frequency of the current producing the field.

In the inductance type of meter, two coils are so interconnected that they tend to rotate a pointer, or iron vane, in opposite directions. The coils are in parallel and one is in series with an INDUCTANCE and the other with a non-inductive resistance. When this system is connected to the source to be measured the current passing through the coil connected to the inductance is inversely proportional to the frequency. Thus, the difference between the forces which the magnetic fields of the coils exert upon the pointer element, and, hence, the deflection of the pointer, is proportional to the frequency.

In the resonance meter, two circuits, each including a CONDENSER, an inductance and a resistance, are con-

nected in parallel and this circuit is then connected in series with a coil. A third circuit, also comprising a condenser, an inductance and a resistance, is connected in series with a second coil, the two coils serving to deflect a pointer. The different circuits are adjusted for RESONANCE at different frequencies, so that the deflection of the pointer is proportional to the frequency.

FRESCO, a process of painting on a wet plaster surface with pigments mixed with water. The chemical action of the wet lime produces a crystalline film of carbonate of lime, which acts as a binding medium, encasing the pigment as it dries and giving a permanent lustrous color. If the process is to be successful the plaster must remain wet while it is being painted. Only a limited amount of the water in the pigments can be absorbed by the wet lime since the carbonate of lime is formed as the water evaporates and is replaced by carbonic acid from the air. If the balance is not maintained crystallization does not take place and the defects in the painting can only be discovered when it is dry. The work must then be done over. The superiority of ancient fresco is in part due to the thickness of the damp plaster; many coats were applied, each about $\frac{1}{2}$ in. thick, and put on before evaporation of the previous coat took place. The final coat must be wet and of a mirror-like surface and only as much of this coat must be applied as can be painted upon at one time. Whatever remains is cut away and fresh wet plaster joined on as the painting proceeds. The cartoon is placed upon the prepared surface, and the colors must be applied with great dexterity, for the plaster surface cannot be overworked. Allowance must be made for the colors drying lighter. They must be mineral in order to withstand the action of the lime and produce a clarity and purity of coloring which is the distinctive charm of fresco painting. Certain earth colors not found suitable for fresco painting have from ancient times been put on by the tempera or *secco* process; in the former the yolk or white of egg is used, or a size; the latter is a process similar to *al fresco* except that the lime water, mixed with pigment, is applied to a dry plaster surface. The earliest example of true fresco known to-day is the Cretan-Mycenaean group of paintings. The history of fresco painting is as intricate as the political and social conditions of the countries and times in which it flourished. Among the finest frescoes in existence are those by Giotto in the Arena Chapel, or Madonna dell'Arena, at Padua, and those in the Church of St. Francis at Assisi by Giotto and his pupils. CORREGGIO, a consummate master of fresco, has left the cupola at Parma as evidence of his genius. But the supreme achievement is the fresco work by MICHELANGELO in the vault of the Sistine Chapel in the Vatican.

FRESENIUS, KARL REMIGIUS (1818-97), German chemist, was born at Frankfort-on-Main, Dec. 28, 1818. He devoted himself intensively to qualitative analysis, casting much light on the sub-

ject and making his books standard texts in that field. He died at Wiesbaden, June 11, 1897.

FRESNO. See **SCRAPERS**.

FRESNO, a city of central California, and the county seat of Fresno Co., situated between the San Joaquin and Kings rivers, about 185 mi. southeast of San Francisco. Transportation facilities include the Southern Pacific and the Atchison, Topeka and Santa Fé railways, bus and truck lines and an airport. The city is located in the heart of the irrigated San Joaquin Valley, noted for cotton, grain, livestock, olives, peaches, figs and especially grapes. Among the manufactures are dried fruit, dairy products, lumber and agricultural implements. In 1929 the value of manufactures was about \$36,000,000; the retail trade amounted to \$53,007,761. The rich Kettleman oil and gas fields are in the vicinity. A few hours distant by motor car are the Sierras and magnificent Yosemite, Sequoia and Gen. Grant national parks. Fresno was laid out in 1874 when the Southern Pacific Railroad came through, and in 1885 received a city charter. Pop. 1920, 45,086; 1930, 52,513.

FREUD, SIGMUND, founder of the doctrine of **PSYCHOANALYSIS**, was born on May 6, 1856, in Freiburg in Moravia which is a tiny village of Czechoslovakia. His family were Jews who had emigrated from Germany. When he was four years of age, his family were in Vienna where he attended school. In 1873 he entered the university, but worked in the physiology laboratory of Ernst Brucke, instead of following a medical course. He worked in this physiologic institute from 1876 to 1882, when he entered the Allgemeines Krankenhaus. He received an M.D. degree in 1881. In 1885 he became Dozent in neuropathology. In the same year he entered the Salpetriere in Paris, where he became associated with Charcot, at first as translator of one of Charcot's works. He returned to Vienna, by way of Berlin, in 1886, where he settled down and married. In Vienna he began to practice as a specialist in nervous diseases. Since 1902 he has been connected with the University of Vienna, being Professor Extraordinary of Neurology.

In 1884 Dr. Breuer related to Freud a case in which symptoms of hysteria were cured by getting the patient to remember, while hypnotised, the way in which the symptoms started. From this original observation rose the conception of Psychoanalysis. In 1895 Freud published with Breuer a work on hysteria. Then came the establishment of the important doctrines of this concept: recognition of the unconscious and its influence upon consciousness; recognition of repression; recognition of the importance of infantile sexuality. In his various works he has called attention to the basic psychologic factors involved in wit, dreams, mythology, literature and religion.

The first international congress on psychoanalysis brought together such disciples of Freud as Adler, Jones Jung, Ferenczi, Brill, and Stekel. To-day there are associations all over the world and the literature of the subject is very large. The seventieth birthday of Freud was honored all over the world. M. F.

FREUNDLICH, EMMY (1878-), Austrian Socialist leader, was born at Aussig, Czechoslovakia, June 25, 1878. Practical experience as a worker aroused her interest in conditions in the textile industry in Moravia and she headed the Socialist women's organization and promoted the cooperative idea. Going to Vienna, in 1911, her interest centered in the furtherance of the cooperatives and the participation of women in their management. In 1919 Frau Freundlich became a member of the Austrian Parliament. The League of Nations invited her cooperation in the work of the World Economic Conference, 1927.

FREY or **FREYR**, in Scandinavian mythology, one of the chief deities, god of the fertility of the earth, the rain and sunshine. He was son of Njord and brother of **FREYIA**. His wife was **GERD**, daughter of the giant **Gymir**. Frey was supposed to awaken the earth in the spring and to give prosperity. Prayers were offered to him at the harvest also. There was a temple to Frey at Upsala, Sweden, where he was especially worshipped.

FREYCINET, CHARLES LOUIS DE SAULSES DE (1828-1923), French statesman, was born at Foix, Nov. 14, 1828. Well educated, and in successful practice as an engineer, he entered upon a political career with the establishment of the Third Republic, and was chief of military organization under Gambetta. In 1877 he became minister of public works, and in 1879 premier and minister of foreign affairs. He was again premier in 1882 and 1886, and from 1888 until 1893 was minister of war. He had a large share in promoting the Franco-Russian military convention. He introduced the three-years' military service, established the general staff, and brought about other reforms. He held the same office again in 1898-99. He wrote a number of books, on economic, scientific, and philosophical subjects, and was a member of the French Academy and the Academy of Sciences. He died in Paris, May 14, 1923.

FREYIA, in Scandinavian mythology, the sister of **FREY** and daughter of Njord, is one of the most important of the goddesses. She was goddess of the fruitfulness of the earth and sexual love. In later legends **ODIN** was said to be her husband.

FREYJA. See **FREYIA**.

FREYR. See **FREY**.

FREYTAG, GUSTAV (1816-95), German dramatist and novelist, was born at Kreuzburg, Silesia, July 13, 1816. The son of a physician and burgo-master, he lived in comparative affluence and received an excellent education, obtaining his doctorate at the University of Berlin in 1838. After teaching several years at the University of Breslau he was associated in 1846-70 with the semi-liberal political and literary journal *Grenzboten*. The rest of his life was spent in voluminous literary activity.

Die Journalisten, 1853, is a popular comedy of social manners. *Soll und Haben* or *Debit and Credit*, 1855, is a realistic novel of every-

FRESCO

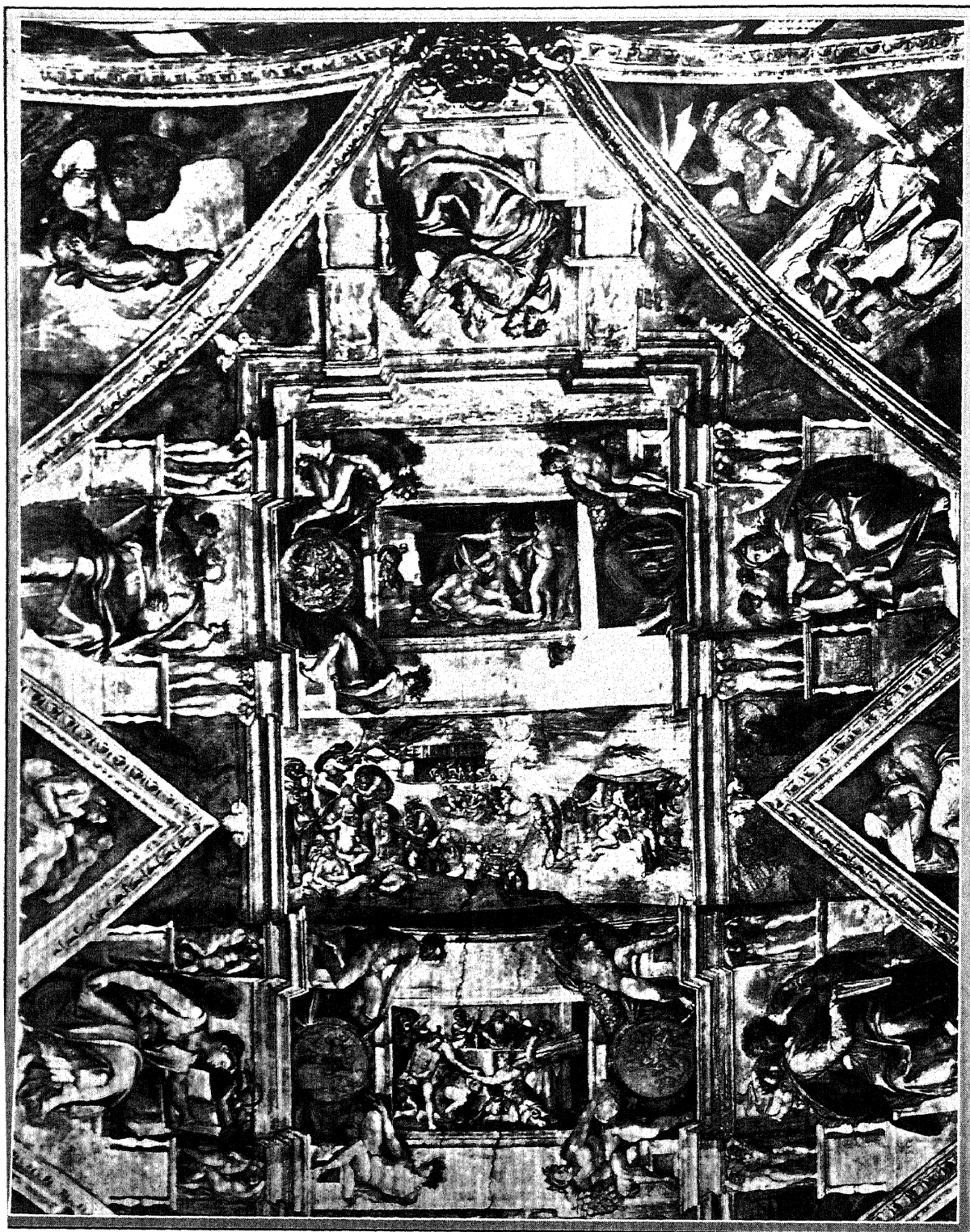


COURTESY METROPOLITAN MUSEUM OF ART

ROMAN MURAL PAINTING

Alcestis offers her life to save her husband Admetus, while his aged parents refuse to aid him. An ancient wall painting found at Herculaneum. In the National Museum, Naples.

FRESCO



ING GALLOWAY PHOTO

SECTION OF MICHELANGELO'S CEILING IN THE SISTINE CHAPEL OF THE VATICAN

iblical scenes in the vault of the Sistine Chapel in the Vatican, Rome. In the center, top to bottom, are: Noah's Ark on the water at a distance; Noah's thank-offering. In the exterior panels are the Prophets and Sibyls, surrounded by angels and genii.

Noah's Ark on the water at a distance; Noah's thank-offering. In the exterior panels are the Prophets and Sibyls, surrounded by angels and genii.

day life. It attained immense popularity. *Bilder aus der deutschen Vergangenheit* or *Pictures of the German Past*, in five volumes, 1859-64, is an attempt to evoke the social life of great historical epochs. *Die Ahnen* or *Ancestors*, 1872-80, is a series of novels that transfers to fiction the last-named work and shows vividly how the torch of civilization is handed on from generation to generation. The above works are considered Freytag's masterpieces. Freytag kindled his pages with the quiet flame of the humanist and scholar, but his work somehow caught the fancy of the German masses and he became one of the most popular writers of the day. He died at Wiesbaden, Apr. 30, 1895.

FRIAR, derived from the Latin *frater*, brother, a term used in the early Christian centuries as a form of address by one Christian man to another, as all were recognized as children of the same Heavenly Father. In the course of four or five centuries it referred specifically to a member of a religious order. The four great orders of friars were the Dominicans, the Carmelites, the Franciscans and the Augustinians. (See articles under these heads.) The Dominicans were sometimes called "Black Friars," even as the Carmelites were called "White Friars" and the Franciscans "Grey Friars" in allusion to the color of their habit. Friars are distinguished from monks, the latter being cloistered, while the former are engaged in an active ministry.

FRIAR TUCK, in Scott's *IVANHOE*, the chaplain to Robin Hood and as merry an outlaw as any in Sherwood Forest. He is enormously fat, lazy and extremely self-indulgent, yet very bold and active in all combats, and endowed with a gift for vulgar wit.

FRIBOURG, a city of Switzerland, capital of the canton of the same name, picturesquely situated on a peninsula formed by the Saane River. It is the seat of the bishop of Lausanne and of a Catholic university opened in 1889. The city rises in terraces and, with its many abbeys and churches, is dominated by the Gothic Church of St. Nicholas, begun in 1283. Other points of interest are the 16th-century city hall, a number of patrician houses, the post office, and near by the hermits' cells carved in the rocks. There is little industry. Pop. 1930, 21,568.

FRICK, HENRY CLAY (1849-1919), American manufacturer, was born at West Overton, Pa., June 17, 1849. He started in the coke business and when twenty-two years of age organized an enterprise that expanded into H. C. Frick Coke Co., which had a daily capacity of 25,000 tons. Frick was a director of the Pennsylvania and Santa Fé railroads and of the U.S. Steel Corporation. He presented a public park to Pittsburgh, and his house containing an extensive art collection to New York City. He died at New York, Dec. 2, 1919.

FRICTION, resistance to the movement of one surface over another. It is a function of the materials used and the conditions of the surfaces. If the surfaces of various substances are prepared as nearly alike as possible, the frictional forces are, for the most part,

a function of the physical characteristics of the material. Thus steel, phosphor-bronze and babbitt metal offer marked differences in frictional properties, and, therefore, one is chosen in preference to the other for BEARING materials in machinery.

In order to have some criterion for the measurement of the frictional properties of matter, the coefficient of friction, M , has been defined as the ratio between the force, F , dragging a body over a surface and the weight, W , of the body. Thus, $M = \frac{F}{W}$. It is in-

dependent of speed and area of contacts. When one body is at rest on another, the starting force, F , is larger than the force to maintain a uniform speed. This gives rise to two coefficients of friction, viz., the coefficient of *static friction* and the coefficient of *kinetic friction*.

The value of the coefficient of friction of a substance is a measure of its suitability for bearing purposes. The advent of ball bearings reduced frictional forces tremendously, so that we very frequently refer to *rolling friction*. Rolling friction also applies to the movements of wheels over roads. While balls, wheels and rollers greatly reduce friction, they do not eliminate it. A ball or a wheel, as it rolls along on a surface, forms a mound or obstruction in the surface in front of it, which resists the motion. The fact that friction has never been eliminated from any kind of a machine, no matter how skillfully it is made, argues against the possibility of PERPETUAL MOTION.

S. R. W.

FRIDA, EMIL BOHUSH. See VRCHLICKÝ, JAROSLAV.

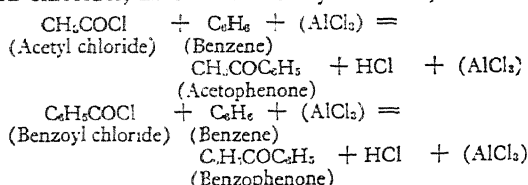
FRIDAY, DAVID (1876-), American economist, was born at Coloma, Mich., Sept. 30, 1876. He studied at the University of Michigan where in 1919-21 he was professor of political economy. He was statistical advisor to the U.S. Treasury Department in 1918. In 1921-23 he was president of Michigan Agricultural College and in 1923 became professor of economics at the New School for Social Research, New York City. In 1927 he was appointed president of the Domestic and Foreign Investors Corporation. He has been retained by industrial corporations to prepare valuations and statistical surveys.

FRIED, ALFRED HERMANN (1864-1921), German publicist and pacifist, was born in Vienna, Nov. 11, 1864. He edited in Berlin *Die Friedenswarte*, the first German pacifist periodical; founded the Austrian-German Peace Society and was an active leader in all pacifist movements. In recognition of his labors for international peace he was awarded the Nobel peace prize in 1911. During the World War he lived in Switzerland and agitated unceasingly against the military policies of the German government. His best-known works are: *Handbuch der Friedensbewegung*, 1911-1913; and *Pan-Amerika*, 1916. He died in Vienna, May 5, 1921.

FRIEDEL, CHARLES (1832-99), French chemist, was born at Strasbourg, Mar. 12, 1832. In 1856 he was attached to the École des Mines, in 1871 became

professor at the École Normale, and in 1876 at the Sorbonne. He worked upon both mineralogical and organic chemical problems, producing organic compounds of silicon and developing a method of synthesizing benzene homologues. He died at Montauban, Apr. 20, 1899.

FRIEDEL-CRAFT'S REACTION, a means of synthesis of compounds, named after the two chemists—Friedel and Craft—who first developed it. It depends upon the reaction which, in the presence of anhydrous aluminum chloride (AlCl_3), takes place between a compound which contains halogen attached to an aliphatic carbon and a compound which contains hydrogen that is attached to an aromatic ring. The "aliphatic halogen" and an "aromatic hydrogen" are given off as hydrogen halide and the aliphatic and aromatic residues combine. Thus ethyl chloride ($\text{C}_2\text{H}_5\text{Cl}$) + benzene (C_6H_6) + AlCl_3 = ethyl benzene ($\text{C}_2\text{H}_5\text{C}_6\text{H}_5$) + HCl + AlCl_3 . By the use of acid chlorides, ketones can be synthesized, thus:



A modification of this reaction whereby an acid anhydride instead of an acid chloride is used, furnished a means of commercially preparing anthraquinone, a compound of great value to the dye industry (*see* DYEING).

In some cases the Friedel-Craft reaction can be reversed. This reversibility was made use of during the World War to prepare toluene ($\text{C}_6\text{H}_5\text{CH}_3$) from a mixture of xylene ($\text{C}_6\text{H}_4(\text{CH}_3)_2$) and BENZINE (C_6H_6), when toluene (*see* TOLUOL) was much needed for the manufacture of TRINITROTOLUENE.

L. C. A.

FRIEDSAM, MICHAEL (1862-1931), American merchant, was born in New York City of Jewish parents in 1862. He was educated at Weston Military Academy and in 1879 was employed by his cousin, Benjamin Altman in his department store. There he soon became an important figure, succeeding to the presidency of the corporation in 1913. Friedsam was a noted art collector and a leader in civic movements, acting as president of the Altman Foundation and the Fifth Avenue Association. He was likewise a director of several banks. His art collection, especially rich in Italian and French masterpieces, is now in the Metropolitan Museum of Art in New York City and is one of the most important bequests received by that museum. He died at New York City, Apr. 7, 1931.

FRIENDLY ISLANDS. *See* TONGA ISLANDS.

FRIENDS, SOCIETY OF, often called Quakers, was first established in England in the 17th century as the consequence of the teachings of George Fox (1624-91), who sought to reduce to a minimum the external forms of religion and emphasize the spiritual

factors in Christianity. He taught that men could know the will of God through the inner light and that there could be and should be a perfect consistency between the outward life and the religious profession. Gathering about him preachers of similar beliefs, he spread the doctrine with their aid throughout the British Isles, the continent of Europe, the West Indies and America. At first they called themselves Children of Truth, also Friends of Truth, and finally the Religious Society of Friends, to which was frequently added the phrase, "commonly called Quakers," a term first applied to them by a judge before whom Fox appeared and whom he called upon to "tremble at the Word of the Lord." Cruel persecution was endured by the early members of the society because of their refusal to attend the services of the Established Church of England, pay tithes, or take oaths of any kind, and not a little ridicule was brought upon them by their insistence on simplicity in dress and speech, peculiarities no longer required of Quakers. At the end of the 17th century they were one of the most important dissenting religious bodies in England, and some of the nation's most prominent families were members. With the cessation of persecution in the 18th century, their missionary zeal relaxed and their numbers have increased but slowly since.

The United States. The Society of Friends consists in the United States of four religious bodies, known as the Orthodox Friends, the Hicksites, the Wilburites and the Primitive Friends, the last being relatively small. At first persecuted in the American colonies, as they were in England, they became surely established and influential in Pennsylvania, the founder of which, William Penn, was one of their number. By the end of the 17th century they had gained a place in most of the colonies. The Quakers were among the earliest Americans to protest against slavery and with the help of the exhortations of John Woolman, voted in 1758 that all in the business should be "disciplined." The Hicksite movement, 1827, and the Wilburite movement, 1845, brought division on doctrinal matters which, however, has not interfered with the most significant principles of the body. The Orthodox Friends, the most numerous, and the other groups, differ from most Protestant denominations on four important points: (1) the great importance attached to the immediate personal teaching of the Holy Spirit, or the Inner Light; (2) the absence of all outward ordinances, including baptism, the eucharist and marriage forms; (3) the manner of worship, which is a gathering in silence until one or more of the members are "moved by the Spirit" to speak; and (4) the doctrine of nonresistance, in accordance with which no Friend feels it right to fight or directly support war.

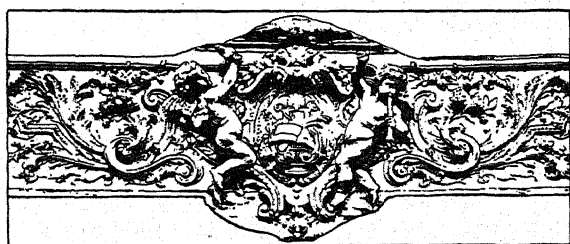
The Friends maintain missionaries in many foreign countries and support much good work for the education of colored people and the improvement of the status of the American Indian. The United States is divided into territories constituted under various yearly meetings. The one in New England was

established in 1661; Baltimore in 1672; Philadelphia, first established in Burlington, New Jersey, 1681; New York, 1695; North Carolina, 1698, and many others during the last two centuries. While the number of Quaker societies does not increase rapidly, membership always shows gains, and it was estimated in 1931 that there were over 100,000 Friends in the United States, scattered in four-fifths of the states. Their chief societies are in Indiana, Ohio, Pennsylvania, North Carolina, Kansas, Iowa, California, New York and Oklahoma, in the order mentioned. They have no ceremony for the ordination of ministers, many of whom support themselves at other occupations. Women are in a position of absolute equality with men in all meetings and societies of the Friends.

FRIENDS UNIVERSITY, a coeducational institution located at Wichita, Kans., was chartered in 1891 and opened in 1898 under the auspices of the College Association of Friends. The institution is privately controlled and non-sectarian. Its productive funds in 1931 were \$650,000. There are 13,605 volumes in the library. In 1930 there were 382 students, and a faculty of 37 headed by Pres. W. O. Mendenhall.

FRIESEKE, FREDERICK, CARL (1874-), American painter, was born in Owosso, Mich., Apr. 7, 1874. He studied in Chicago, New York and Paris. He has mural decorations in the Hotel Shelburne, Atlantic City, and in the Wanamaker Auditorium, New York City. His paintings hang in galleries in the principal cities of the United States. Examples of his work are *The Toilet*, in the Metropolitan Museum, New York, and *The Open Window*, Chicago Art Institute.

FRIES' REBELLION, 1799, an uprising in Pennsylvania against the enforcement of the "window tax." In July, 1798, Congress levied a direct tax apportioned among the states. In Pennsylvania the assessment fell chiefly upon lands and houses, the value of the latter being computed by the number and size of the windows. At Bethlehem, where 30 men were jailed for opposing the assessment, a mob led by John Fries overawed the marshal into releasing the prisoners. Five days later, on Mar. 12, President Adams proclaimed a state of insurrection, calling out the militia; Fries and other rioters were taken to



FRIEZE IN THE LOUVRE, PARIS

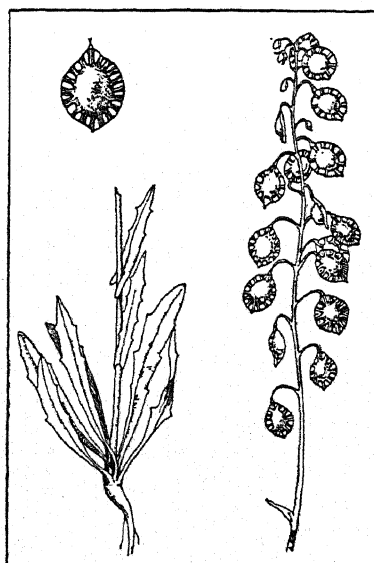
Philadelphia and indicted for treason. A sentence of death against Fries was reversed and remanded when his counsel proved that one of the jurors had expressed a vindictive prejudice. At his second trial

Fries was again given a capital sentence; but President Adams in April, 1800, pardoned him and issued a general amnesty to participants in the uprising.

FRIEZE, in architecture and the decorative arts, a horizontal decorative band. In classic architecture, a frieze forms the middle member of the ENTABLATURE between the cornice above and the architrave below.

FRIGATE, a term given to long vessels using both sails and oars, common on the Mediterranean Sea about 1600. By the end of the 18th century, frigates had taken the principal place in the line of battle. As finally designed, a frigate was constructed to carry her guns on a single whole deck, a quarter-deck, and a forecastle. Steam frigates were launched in 1855, and cost about \$1,000,000 each, to build. They were slowly superseded by ironclads after 1870.

FRIGATE BIRD (*Fregata magnificens*), a large, blackish sea bird allied to the gannets and pelicans, called also man-o'-war bird. It is found on tropical and subtropical coasts in the New World, ranging as far north as California and the Gulf coast. The frigate bird, which somewhat exceeds 3 ft. in length, is remarkable for its very short legs, greatly elongated wings, deeply forked, swallow-like tail and long, strongly hooked bill. The male possesses a bright scarlet throat pouch which can be inflated to a great size. Frigate birds are noted for their extraordinary powers of flight, soaring with extreme lightness and grace, often at great heights, without perceptible motion of their wings. They feed upon fish, which they



FROM JEPSON MAN. FL. PLANTS CALIF.. COPYRIGHT

FRINGE-POD

Pod, base of plant and flowering branchlet

steal from other sea birds or capture for themselves by a swift dart from above. At breeding time they form colonies and nest in bushes or on rocks, laying usually a single pure white egg. On the ground or on quiet water they are helpless to rise.

FRINGE-POD (*Thysanocarpus curvipes*), a small slender annual of the mustard family found widely

in hilly districts, from British Columbia to central California and eastward to Idaho. It grows about a foot high, bearing narrow, somewhat wavy-toothed leaves, minute whitish flowers, and much flattened, disk-shaped pods pierced near the margin with numerous small holes.

FRINGE-TREE (*Chionanthus virginica*), a handsome large shrub or slender tree of the olive family, called also old-mans-beard. It grows on river banks from Pennsylvania to Florida and Texas and is often planted as an ornamental. The tree bears dark green leaves, 4 to 8 in. long, and loose drooping clusters of white flowers with elongated, fringe-like petals.

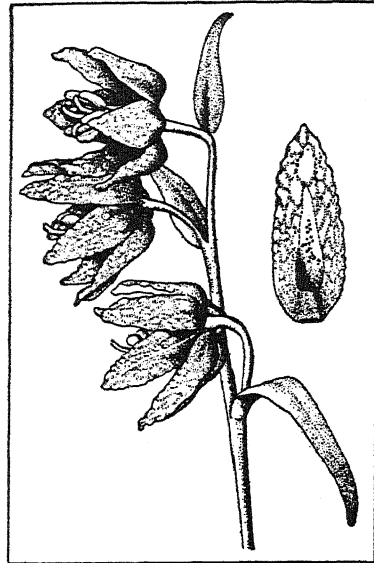
FRISIAN, a west GERMANIC language best regarded, together with English, as a distinct subdivision of the Germanic languages (Anglo-Frisian or Ingvaenic). Its oldest monument is an interlinear translation of the Psalms of the 11th or 12th century, with little else than laws and codifications until the 16th. Old Frisian is divided into two dialects: West Frisian, west of the Lauwers Zee in the Netherlands, and East Frisian, eastwards to the mouth of the Weser. Modern Frisian shows three distinct dialects: West Frisian ("peasant" or "land" Frisian), spoken on the islands of Terschelling and Schirmonnikoog as well as in a part of the Dutch province of Friesland; East Frisian, between the Lauwers Zee and the mouth of the Weser, mostly crowded out by Low GERMAN but still found on the island of Wangeroog and in some parts of the Saterland; and North Frisian, of which no older monuments are extant, mixed with Danish and Low German elements, and spoken on the west coast of southern Jutland and Sleswig, and in the islands of Sylt, Fohr, Amrum and Heligoland. E. Ro.

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FRISIAN ISLANDS, a group of low-lying islands in the North Sea, flanking the coasts of Germany and Holland and extending from the ZUIDER ZEE to JUTLAND. The chain comprises three groups known as North Frisian, West Frisian and East Frisian Islands. The West Frisian, which include Texel, Terschelling, Ameland and some smaller ones, belong to the NETHERLANDS. The East and North Frisians, with the exception of Rom and Fano, which are Danish, belong to Germany. For centuries the islands have slowly been disappearing under the wash of the sea; vegetation is scanty because of the sandy soil. Sea-fishing and the raising of cattle are the chief occupations of the natives.

FRITILLARY, the common name for a genus (*Fritillaria*) of handsome plants of the lily family. There are upwards of 50 species widely distributed in the north temperate zone, some 15 occurring in the western United States. They are mostly low, early-blooming bulbous plants with unbranched stems and hanging, lilylike, purple, red, brownish or whitish, usually spotted flowers. The species most cultivated in the United States include the snakes-head or

checkered-lily (*F. meleagris*) and the crown-imperial (*F. imperialis*), both of the Old World. Among the native species, which include some of the most attractive western wild flowers, are the mission bells



FROM JEPSON MAN. FL. PLANTS CALIF. COPYRIGHT

MOTTLED FRITILLARY OR CHECKER LILY
Flower cluster and segment of flower

(*F. biflora*), the checker lily (*F. lanceolata*), the adobe-lily (*F. pluriflora*), and the scarlet fritillary (*F. recurva*).

FROBISHER, SIR MARTIN (c. 1535-1594), British explorer, was born in Doncaster, about 1535. He was early known as an able seaman and in 1576 was given ships by Queen Elizabeth for the purpose of finding a northwest route to Asia. On this expedition, he explored the Labrador coast, and discovered a large bay which he named after himself. On his return to England, another expedition was organized in 1577 and still another in 1578, but neither were commercial successes. With Sir Francis Drake he went to the West Indies in 1585 and in 1588 helped defeat the Spanish Armada. Again in 1590 and 1592 he fought against Spain and was sent in 1594 to aid Henry VI of France. While fighting at the siege of Brest, he was wounded, from the results of which he died in Plymouth, Nov., 1594.

FRÖDING, GUSTAV (1860-1911), Swedish poet, was born near Karlstad, Aug. 22, 1860. Fröding became a student at Upsala University. After a few years he returned to Karlstad and became a journalist. Some of his early poems were printed in *Karlstadtidningen*. Fröding's first book of poems was *Guitar and Concertina*. These poems dealt with Vermland types from town and countryside. Other volumes are *New Poems, Splashes and Rags, New and Old, Grail Splashes, Gleanings and Reconvalescentia*. For several years Fröding was completely insane, but his mind began to clear four years before his death. His best work is to be found in his two volumes of *Collected Poems*. He died at Stockholm, Feb. 8, 1911.

FROEBEL, FRIEDRICH WILHELM AUGUST (1782-1852), German educator and founder of the kindergarten, was born at Oberweissbach, Thuringia, Apr. 21, 1782. In 1799 he went to Jena, where he studied for a year and a half. He was an actuary clerk at Bamberg, 1802-3, and an accountant in Baireuth and Mecklenburg in 1804. In 1805 he became a teacher in a model school in Frankfort, whose headmaster was a disciple of JOHANN PESTALOZZI. A brief visit with Pestalozzi convinced Froebel that he wanted to study his methods at close hand, and in 1807 he took a group of his pupils to Yverdon, where he remained for two years. Greatly inspired by Pestalozzi's educational theories, he determined to devote himself to working for educational reforms and went to the University of Göttingen, 1811, and the University of Berlin, 1812, to study further. In 1816 he founded the Universal German Educational Institute at Griesheim where he worked out his theories. This school was moved the following year to Keilhau. In 1835 Froebel founded an orphanage at Burgdorf which later, 1837, led to his opening a kindergarten at Blankenburg. This was closed in 1844, and Froebel lectured for a few years on women's education. In 1850 he opened a training college in Marienthal, and also founded the *Weekly Journal of Education*.

Froebel believed that the creative rather than the imitative powers of the child should be developed and that play should be used for his educational development. For this purpose he invented progressive gifts and occupations. He died at Marienthal June 21, 1852. M. R.

See R. H. Quick, *Educational Reformers*, 1890; P. R. Cole, *Herbart and Froebel; an Attempt at Synthesis*, 1907; W. H. Kilpatrick, *Froebel's Kindergarten Principles*, 1916.

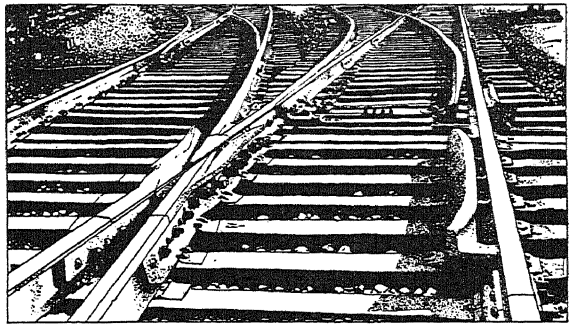
FROG, a name which is popularly given to any of the smooth-skinned, long-legged tailless amphibians, as opposed to "toad," for their rough-skinned cousins, with shorter hind legs. True frogs (*Ranidae*) are found almost all over the world, and there are some 200 species in the widely distributed genus *Rana* alone. Certain species dig burrows in the earth, others live in trees, but most frogs are never far from the water. The well-known common frog is found in nearly every marsh and pond, and its "song" is one of the most familiar signs of spring. A very common American frog is the big greenish or brownish bullfrog (*Rana catesbiana*), which may be 5 to 8 in. long. This frog furnishes the frogs' legs used for food.



BULLFROG

Frogs lay their eggs in the water, where they hatch into tiny larvæ with external gills and long tails. The larvæ grow into big tadpoles with fishlike gills, and these grow legs and lungs, absorb their tails, and finally become mature frogs.

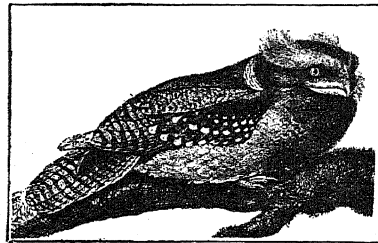
FROG, in railroading, a device providing flange-ways through the rail heads where "gauge" lines of rails intersect, as at SWITCHES and crossings.



COURTESY NEW YORK CENTRAL LINES

SECTION OF RAILWAY TRACK, SHOWING RAIL-BOUND FROG

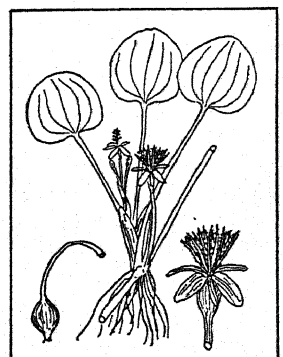
FROGMOUTHS, the common name for a family (*Podargidae*) of birds closely allied to the goatsuckers, native chiefly to the Malayan and Australian regions. They are so named because of their enormously wide-

EARED FROGMOUTH
Batrachostomus auritus

ened and flattened bill, which somewhat resembles the gaping mouth of a frog. Frogmouths vary greatly in size, ranging from 7 to 21 in. in length, and have soft plumage mottled with gray, brown, black and white. In habit they are strictly nocturnal, feeding largely upon insects, which they catch on the wing. See also GOAT-SUCKERS.

FROGS-BIT (*Hydrocharis Morsus-ranae*), a delicate floating plant found widely in ditches and ponds in Europe and Asia and often grown as an ornamental in aquaria. The runner-like stems bear thick, roundish, heart-shaped leaves, about 2 in. across, small white flowers on long stalks and a podlike fruit. The American frogs-bit (*Limnobium Spongia*), native to still waters in the southern United States, has numerous pendent roots, long-stalked leaves and a small berry-like fruit.

FROHMAN, CHARLES (1860-1915), American theatrical producer, was born at Sandusky, Ohio, June



P. A. RYDBERG. "FLORA OF PRAIRIES AND PLAINS"

AMERICAN FROGS-BIT

17, 1860. In youth he was an office-boy for the New York *Daily Graphic*, and sold tickets at Hookey's Theatre, Brooklyn, N.Y. In 1877 he managed the western tour of *Our Boys*, and went to Europe with Haverley's Minstrels for a tour in 1879-80. He saw *Shenandoah* in Boston in 1889 and bought it, making a fortune in its production. In 1892 he organized a stock company in New York. He acquired several New York theaters, and with the Empire Stock Company brought into prominence such players as MAUDE ADAMS, Ethel Barrymore (see BARRYMORE FAMILY), John Drew (see DREW FAMILY), Billie Burke and Julia Sanderson. He also managed several theaters in London, where he attempted to establish a repertory theater and inaugurated the present system of international play exchange. At London he became a close friend of J. M. BARRIE, whose *Peter Pan* Frohman produced in 1897, with MAUDE ADAMS in the title rôle, with phenomenal success. He died May 7, 1915, in the sinking of the *Lusitania*.

FROHMAN, DANIEL (1853-), American theatrical manager, was born at Sandusky, Ohio, Aug. 22, 1853, a brother of CHARLES FROHMAN. After various theatrical ventures he became manager of the Fifth Avenue Theatre, New York City, and of the Madison Square Theatre, during 1879-85, in the latter year undertaking the operation of the Lyceum Theatre. He managed Daly's Theatre in 1899-1903 where he organized the Daniel Frohman Stock Company. Celebrated American and English players appeared under his management. In 1912 he was one of the organizers of the Famous Players Film Company.

FROISSART, JEAN (c. 1337-c. 1410), French historian, was born at Valenciennes. At an early age he turned to a literary career and went to England in 1391 to enjoy the patronage of Queen Philippa. From then on his life is that of a professional litterateur, patronized in turn by the Black Prince; the Duke of Clarence; King Peter of Cyprus; Wenceslas of Luxemburg; Guy of Blois, Lord of Beaumont, and Gaston Phoebus, Count of Foix. From Guy of Blois in 1373 he received the benefice of Lestines where he resided for ten years. He early became interested in the history of his own times and, encouraged by his various patrons, he journeyed at one time or another to Scotland, Guienne, Italy, Gascony and various parts of France and the Low Countries. On these occasions he was active in talking to persons who had been participants in contemporary events, both in those regions and in more distant parts such as Spain, Portugal, Cyprus and Prussia. The information which he gathered he wrote up into a voluminous and informing history of the 14th century, a work which has been very popular for 500 years. As an historical source it has the weaknesses of its author and his method. Froissart was superficial in his approach and on the whole, uncritical in his method. He is particularly valuable for the picture which he gives of aristocratic society and decadent chivalry during the first part of the Hundred Years War.

R. A. N.

FROMENTIN, EUGÈNE (1820-76), French painter and author, was born at La Rochelle, Oct. 24, 1820. Fromentin's visits to Algeria enabled him to bring a scientific accuracy to his interpretations of desert life. His early canvases combined striking composition with colors of delicate gradations, while the waning power and rather artificial elegance of his later works has been attributed to a failing physique. The Metropolitan Museum, New York, has his characteristic *Arabs Crossing a Ford*. Fromentin, the orientalist, did not survive the decline of the cult; Fromentin, the author of *Les Maîtres d'Autrefois*, published 1876, remains the outstanding art-critic of 19th century France. He died at La Rochelle, Aug. 27, 1876.

FRONDE, THE, was in essence an attempt to undo Richelieu's (see RICHELIEU, CARDINAL) destruction of the power of the French nobility. CARDINAL JULES MAZARIN, the actual power during the minority of Louis XIV, was continuing his predecessor's work. The spark which opened the civil war of the Fronde in 1648 was a rising in Paris moved partly by popular disgust with Mazarin's financial pressure and partly by discontent of the nobles. It soon showed its true colors when its princely leaders attempted to call in the aid of Spain. This was too much for bourgeois Paris, ever the friend of the Crown against the nobility, so that Paris as a moving factor in the Fronde thereupon disappeared, Apr. 1649.

The further course of the Fronde was strictly a civil war of the great nobles against Mazarin as representative of the absolutist, centralized royal state. The war was marked chiefly by the intrigues which ran through it and the shifting from side to side of the two great soldiers VISCOUNT DE TURENNE and LOUIS II DE BOURBON CONDÉ. At the end the nobles secured Spanish aid but were defeated by the royal army in Feb. 1653. See HUGUENOTS.

FRONTENAC ET PALLUAU, COMTE DE (LOUIS DE BUADE) (1620-1698), French military commander, governor and lieutenant-general of New France, was born in 1620. In military service from 1635 to 1648, when he fought in Holland, the Low Countries and Italy, Frontenac in civil life lived extravagantly beyond his means. He won military glory as commander of a contingent of French troops fighting at Crete against the Turks in 1669, and in 1672 was appointed governor of New France. At Quebec his policy was one of territorial aggrandizement and he showed great skill in Indian relations. His intention to set up the tri-state social system of France and his impetuosity and independence led to the reinstatement of the *intendant* as a curb upon the governor. His quarrels with the *intendant* and with LAVAL, Bishop of Quebec, resulted in the return in 1682 of both Frontenac and the *intendant*. Since the Iroquois (see IROQUOIS-FRENCH WARS) were manifesting unrest, Frontenac's recall was ill-timed; by 1689 Indian hostilities had brought the affairs of New France to a precarious state, and Frontenac was returned to Quebec as governor. He repulsed the at-

tack of the New England naval force led by Sir William Phipps against Quebec in Oct. 1690, reinvigorated the fur trade to meet English encroachments, and compelled the Iroquois temporarily to evacuate their villages. Further military expeditions, the building of fortifications and the strengthening of the fur trade which he had planned were cut short by his death at Quebec on Nov. 28, 1698.

FROST, ROBERT (1875-), American poet, was born in San Francisco, Cal., Mar. 26, 1875, of Scotch and New England parentage. He was educated at Dartmouth College and Harvard University, and then taught English and psychology in New England schools. From 1912-15 he studied and traveled in Europe, publishing in England his first two books of poetry, *A Boy's Will* and *North of Boston*. From 1916-20 he was professor of English in Amherst College. In 1921 he was appointed Poet in Residence at the University of Michigan, then returned to Amherst for a two-year professorship. In 1925-26 he was again at the University of Michigan as Fellow in Letters, but returned in 1926 to Amherst. He published *Mountain Interval*, 1916; *New Hampshire*, 1923, and *West Running Brook*, 1928. Frost's poems are chiefly in free verse, and he achieves notable effects of power and sincerity by his use of everyday words and simple rhythms. He was awarded the Pulitzer Prize for Poetry in 1924. In 1930 a collected edition of Frost's work was published, revealing him as the modern interpreter of rural New England. The following year the poet was awarded the \$1,000 Russell Loines Memorial Prize and the Pulitzer Prize for Poetry in 1931.

FROST, the layer of small ice particles which forms upon objects near the ground by the freezing of the moisture in the air. It is entirely analogous to Dew, the only difference being that in the case of frost the air is chilled below the freezing point where liquid water cannot exist and hence the water vapor in the atmosphere, in condensing, is deposited in tiny ice-crystals, instead of as dew drops.

As with dew, the conditions most favorable for the formation of frost are a clear sky and a calm atmosphere. A clear sky allows of a more rapid radiation of heat from the ground, with its consequent lowering of temperature. In a calm atmosphere the lowest layers of air, in contact with the ground, remain in place and cool quickly below the freezing point instead of being disturbed by the wind and mixed with higher and still warmer air. For this same reason frosts sometimes occur in valleys and not on adjacent hills, especially in autumn; the cold air settles down into the lowest place if not disturbed.

Naturally, frost is of almost daily occurrence in winter, but it also takes place occasionally all through spring and autumn, and sometimes during the summer. In late spring or early autumn, such a frost may cause considerable damage to agriculture and fruit farming; in the former case by freezing the blossoms, in the latter by freezing the crop, and in either

case injuring or killing the plant. In the California fruit orchards the peril of frost is combated by smudging, or throwing a dense smoke screen around the trees, which prevents excessive radiation and stirs up the air, as well as imparting some heat to it.

The term frost is likewise used to indicate the formation of ice, by freezing, of exposed masses of water. As such it may be considered to exert a beneficial influence since in the freezing of water in cracks and crevices, the expansion incident upon solidification may split rocks and thus start the process of soil formation.

Like snow, frost crystals are of a great variety of shapes, being in the main triangular and hexagonal in form, and they may be roughly classified into tabular and columnar types. The beautiful and delicate structure of frost formed on the inside of a window pane by the freezing of the water vapor in the room against the glass which is cooled by the outside air, is a well-known winter phenomenon.

W. J. L.

FROST-BITE, inflammation and death of localized portions of the body as a result of freezing. The affected region first becomes white, anemic, and insensible. Later, when it thaws, it becomes red and painful. A number of days afterwards ulcers may form, or the part may become discolored and gangrenous.

To prevent pain and subsequent gangrene, the parts should be rubbed with snow or ice, and thawed slowly. Local stimulants as turpentine or camphor, if kept in contact with the frost-bitten region, will greatly aid recovery and prevent gangrene.

FROSTBURG, a town in Allegany Co., northwestern Maryland, situated on a plateau about 1,100 to 1,400 ft. about sea level. Two railroads afford transportation. The town is in an important coal-mining district. Meshach Frost, in 1812, founded the town, which was called Mount Pleasant until 1830. Frostburg was incorporated in 1870. It is the seat of a state normal school, founded in 1904. Pop. 1920, 6,017; 1930, 5,588.

FROSTWEED (*Helianthemum canadense*), a hoary perennial of the rockrose family, native to the eastern United States and Canada. It grows 1 to 2 ft. high, bearing narrow oblong leaves and solitary, terminal, bright yellow flowers, an inch across, which are succeeded by clusters of very small flowers borne in the leaf axils. In late autumn ice-crystals sometimes shoot from the cracked bark at the base of the stem.

FROUDE, JAMES ANTHONY (1818-94), English historian, was born at Darlington, Devonshire, Apr. 23, 1818. He was educated at Oxford. In 1856 the first two volumes of his *History of England* were published; the work was completed in 1870. His historical writing is distinguished by its dramatic character and its marked emphasis on personality. Froude is perhaps more noteworthy as a stylist than for the accuracy of his historical data. He was Carlyle's literary executor and in that capacity published

that writer's *Reminiscences* and *Memorial of Jane Welsh Carlyle*. He has been sharply criticized for this, although it was done with Carlyle's permission. Froude died at Salcombe, Oct. 20, 1894.

FRUCTOSE, also known as fruit sugar, or LEVULOSE, an organic chemical substance belonging to the CARBOHYDRATES, and having the formula $C_6H_{12}O_6$, occurs in many ripe fruits, usually mixed with glucose. It is a monosaccharose, but is different in structure from the majority in that it possesses a $C=O$ group, and is thus, in a sense, a ketone, but also an alcohol, from which it is called a ketose. Its solution rotates the plane of polarization of light toward the left, from which it derives its name levulose. It is one of the products of the process known as INVERSION, taking place when ordinary sugar or sucrose is hydrolyzed into a mixture of glucose and fructose. Fructose reduces Fehling's solution and is pleasantly sweet to the taste.

FRUGONI, CARLO INNOCENZIO (1692-1768), Italian poet, was born at Genoa, Nov. 21, 1692. He most completely embodies the ideals of the Arcadian school of poetry, and the word *frugoneria* was invented to describe his bombastic style. Frugoni wrote over 2,000 poems on such subjects as a basket of mushrooms. Sentimental and superficial, he was, however, a skilled writer in blank verse. Frugoni died at Parma, Dec. 20, 1768.

FRUIT. With seed production (*see* FLOWER), the ovary and sometimes adjacent tissues develop into a protective covering which aids in seed distribution at maturity. This structure, whether dry or fleshy, is called a fruit by the botanist, although the layman restricts the term to certain edible fleshy forms. Other fleshy forms (squash, cucumber, egg-plant), commonly called "vegetables," are also, botanically, fruits. Fleshy fruits include the thin-skinned berry (blueberry) with seeds imbedded in pulp developing from the ovary wall; stone fruits or drupes (peach) in which the ovary wall forms two layers (a fleshy and a stony) about the seed; and pome (apple) with a core representing the ovary, surrounded by flesh coming, in part, from the growth of the flower-stem, originally below the flower. Dry fruits are of two sorts. Pods, that open along definite lines, like the legume (pea) which cracks along both sides, and capsules (pansy) of more than one chamber, are contrasted with the indehiscent forms. In the latter the transformed ovary wall or pericarp does not open naturally. Here are found the grain of cereals and the nut, each of which is usually one-seeded. Other interesting fruits are made from a number of individual ovaries (blackberry), sometimes associated with other tissues, as in strawberry where the dry fruits, often called "seeds," are carried on the stem-tip which becomes red and fleshy. Fruits are usually the result of fertilization and accompany seed formation, but, as noted above, exceptions occur in seedless oranges, cultivated bananas and pineapples.

Frequently there are outgrowths on fruit which aid in dispersal of the contained seed. The calyx may

remain as fine hairs that help in wind dispersal, for example, the dandelion and similar fruits. Other dry fruits with prickles or stickers are carried about by animals. Fleshy fruits because of attractive color, odor or taste, are apt to be consumed as food by birds and other animals.

The cultivation of edible fleshy fruits has become of great economic importance as one branch of horticulture. Great progress has been made in their improvement. Such fruits are characterized by high water content, much carbohydrate (sugar), and often by pectin, responsible for the ability of the juice, when heated, to form jelly. This is in contrast with dry fruits where the chief food value, if any, lies not in the ripened or matured ovary wall, but in the seed itself; this is usually low in water content, with a high content of starch, oil or protein, as in nuts.

N. E. P.

Fruit as a Food. Fruits grown in sufficient quantities to be of commercial importance include the orchard fruits: apples, peaches, nectarines, plums, prunes, pears, cherries, apricots and quinces; the citrus fruits: oranges, lemons, grapefruit, limes, tangerines and kumquats, and the "small fruits": strawberries, raspberries, blackberries, currants, gooseberries and cranberries.

The chief nutritional significance of fruits is as a source of iron and other minerals, and vitamins (*see* VITAMINS IN FOODS), particularly vitamins B complex and C. They also contain varying amounts of sugar and indigestible fiber, or cellulose. The acidity of fruits is due to the potassium salts of organic acids, such as the acid potassium citrate of oranges. When the organic acids are burned (oxidized) in the tissues of the body, they yield an alkaline (basic) substance, potassium bicarbonate, which is itself neutral, but is capable of neutralizing any acids which may be present, thus preserving the normal approximate neutrality of the blood and tissue fluids. (*See* BUFFER ACTION.) Because of this property, fruits, with very few exceptions, are known as base-forming foods, and it is one reason for including them in the daily diet. The liberal consumption of fruits stimulates intestinal peristalsis, thus preventing constipation, and helps to prevent intestinal putrefaction.

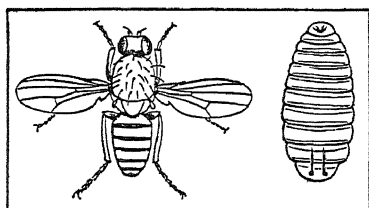
Most unripe fruits contain some starch, which, during the ripening process, is changed to sugar. The acidity of the fruit decreases as it ripens. Oxidation processes go on in ripening fruit, with the development of "ethereal substances" and the evolution of carbon dioxide. There appears to be a decrease of the pectin substances as fruit ripens, since partially ripe fruit makes a firmer jelly than that which is entirely ripe.

Fruits are preserved by canning and drying. The effect of canning on the vitamin content of fruits varies with the fruit and the processes used. In general, the methods of handling and cooking used in commercial canning are less destructive of vitamins, particularly vitamin C, than are home canning methods. This is because air can be excluded from the

cans during the sterilization of the fruit as it is done commercially, which reduces the amount of oxidation to a minimum, conserving the vitamins. See also *FOOD FOR THE INDIVIDUAL*. H. T. B.

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FRUIT FLY, a popular name for certain flies of the family *Trypetidae*. The majority are beautifully marked minute insects, also known as peacock flies, because they strut up and down with their wings



FRUIT FLY
(*Drosophila* sp.). Adult and larva

spread. The apple maggot is a destructive species, widely distributed in Canada and the northeastern part of the United States. Its white larvæ make brown tunnels through apples, which they thus ruin for food. In like manner related species of cherry-worms and currant and gooseberry worms destroy these fruits. In Mexico the morelos fruit fly lays its eggs on immature citrus fruits, which the maggots soon destroy. Of similar habit is the widely known Mediterranean fruit fly. In spite of stringent quarantine regulations, this foreign pest of subtropical regions gained a foothold in Florida in 1929. The infestation was severe in some parts of the state. Strict quarantine, and the immediate destruction of material which was or might be infected, was carried out by federal and state authorities. This fly attacks not only citrus fruits, but likewise the fruits of many other trees, and many garden vegetables. J. R. T.

FRUIT GROWING is distinctly an American term. Strictly it applies to the commercial production of fruit in contradistinction to fruit gardening of which it is the development. From the time of the earliest settlers until less than a century ago every farm and garden had its orchard and berry patch. As city populations grew demands for fruit increased and specialist fruit growers multiplied until now whole farms and even entire districts are devoted mainly to the industry. Other factors that have helped are better cultural methods, power tools, control of crop enemies, grading, improved packages, rapid transit, refrigerator cars and cold storage. Most of this development has occurred within the past quarter century. No other country approaches America in fruit production and disposal and no branch of American farming shows more effective adjustment to conditions and demands. See *HORTICULTURE*. M. G. K.

FRUIT JUICES. See *BEVERAGES*.

FRUIT SUGAR. See *FRUCTOSE*.

FRUSTUM, a term used in geometry, ordinarily applied to a regular pyramid or a cone of revolution,

meaning a portion included between the base and a section parallel to the base.

In each case, if B is the base and B' is the area of the section, the upper base, and if V is the volume and h the height, then

$$V = \frac{1}{3} h (B + B' + \sqrt{BB'}).$$

The term is also applied to irregular pyramids and cones. This is one of the oldest rules of mensuration, being found in an Egyptian manuscript of about 2000 B.C.

FRY, WILLIAM HENRY (1813-64), American music critic and composer, was born at Philadelphia, Pa., Aug. 10, 1813. During 1845-46 he was on the staff of the *New York Tribune*, in 1846-52 serving as foreign correspondent. In addition to symphonic poems and overtures, he composed the operas *Leonora*, produced at Philadelphia in 1845, and *Notre Dame de Paris*, given at New York in 1864. He died at Santa Cruz, West Indies, Sept. 21, 1864.

FRYER, JOHN (1839-1928), English educator, was born at Hythe, Kent, England, Aug. 6, 1839. He graduated at Highbury College, London, in 1860 and from 1861-67 taught at colleges in China, first at Hongkong, then at Peking and lastly in Shanghai. From 1867-96 Fryer directed the translation of foreign scientific books into Chinese, at the Imperial Government Arsenal in Shanghai. During these years he founded the Chinese Scientific Book Depot and the Institution for Chinese Blind, both at Shanghai. Fryer wrote more than 100 books in Chinese and compiled, among other writings, his *Educational Directory for China*, 1895. He was professor of Oriental languages and literature at the University of California, 1896-1914, when he became professor emeritus. Fryer died July 2, 1928.

FUCHSIA, a genus of numerous shrubs and small trees of the evening-primrose family found mostly in tropical America, a few of which have become widely cultivated in various forms as pot and garden ornamentals. The common garden fuchsia (*F. hybrida*) is a shrubby, usually, smooth plant with oblong toothed leaves and showy hanging flowers, the parts of which are arranged in fours. The outer tubular portion (calyx) is usually crimson and the inner parts (petals) are purple, rose or white. The many forms in cultivation are believed to be hybrids derived from two Mexican species (*F. fulgens* and *F. magellanica*).

FUCHSINE, a purple-red synthetic dye whose dry crystals have a greenish luster, also known under the names of magenta, rosine, rubine, pararosaniline, or aniline red, belonging to the class of *TRIPHENYLMETHANE* dyes. It may be prepared by the oxidation of aromatic amino-compounds such as aniline and toluidine in which process rosaniline appears as an intermediate substance. Its structure is very complicated, and consists of three benzene rings united to a single carbon atom, and three amino groups. In dyeing cotton with it, the fiber has to be mordanted with tannic acid and metallic salts, but silk and wool take it directly; it is also used to color candies.

FUEL ANALYSIS, is used for determining the properties of gaseous, liquid and solid fuels and classifies them for their proper uses. Gaseous fuels are analyzed according to the procedure of GAS ANALYSIS.

Different uses require different properties of the fuel, for instance, gasoline and fuel oil are quite different in their physical properties, the former being used in an automobile engine where it has to vaporize easily, while the latter may be used in a Diesel engine or in a furnace, where it is atomized through a jet by means of compressed air. Similarly, coal for a gas producer will have to satisfy entirely different requirements than coal used on a chain grate or a domestic furnace.

Two types of fuel analyses are in use. One is the ultimate analysis, which records the per cent of chemical elements of carbon, hydrogen, nitrogen, oxygen, and sulphur. The other one, which is more important from the technical standpoint is the proximate analysis. It records moisture content, volatile matter, fixed carbon, ash and sulphur. Both types of analyses are applicable to all kinds of liquid and solid fuels.

The fuel analysis also includes the determination of the heating value of the fuel, which is the number of heat units liberated by combustion per pound or gallon of fuel. K. K.

FUELING STATIONS are located at various sea ports, on or near trade routes, where vessels can stop and get coal and oil. Due to increased economy of marine engines and the longer runs they can now make, many of the early coaling stations are being abandoned.

Important fueling or "bunkering" stations in the Atlantic Ocean are located at St. Thomas, W.I.; Bermuda, Gibraltar, Sierra Leone, Cape of Good Hope and Falkland Islands. In the Mediterranean Sea, at Malta and Port Said; Red Sea at Suez and Perim; Indian Ocean at Mauritius, Colombo and Bombay; Singapore and Hong Kong in the Far East; in the Pacific Ocean at Hawaii, Samoa and Fiji Islands, while in Australia are the important stations of Fremantle, Sydney and Adelaide.

FUELS, materials used to produce heat or develop power upon COMBUSTION. COAL, oil (*see* OIL FUEL) and NATURAL Gas produce about 95% of the artificial energy supply of the U.S., bituminous coal producing 53%, anthracite 8% and petroleum 25% at the close of the third decade of the 20th century.

Coal. The various groups of coal and allied compounds named in the order of their geological ages are: GRAPHITE, anthracite, semi-anthracite, semi-bituminous, bituminous, sub-bituminous, LIGNITE, peat, and wood or cellulose. The forms of wood or cellulose in common use are: cordwood, Hog FUEL, sawdust, shavings, refuse of woodworking plants and saw mills, bagasse, tanbark, straw and stubble. Coke, charcoal and fuel BRIQUETTES are manufactured fuels prepared from coal or wood. Graphite, or graphitic anthracite, even with special treatment is difficult to burn in boiler furnaces, but under suitable conditions it may be used in the gas producer. Anthracite, or hard coal, is prac-

tically all fixed carbon. It has a deep black color, a shiny semi-metallic luster, few cleavage planes, is compact, and sometimes iridescent. It is difficult to light and burns with a short, smokeless flame. *Semi-anthracite* is not as hard or dense as true anthracite and does not have its luster. It contains 5 to 10% volatile or gaseous matter and hence, kindles and burns more rapidly than true anthracite. *Semi-bituminous coal* is softer than semi-anthracite, and is brighter in appearance than bituminous. It contains in general 15 to 22% of volatile hydro-carbons, kindles more easily and burns more rapidly than anthracite. It is ordinarily free burning, smokeless and has the highest heating value of any type of coal.

Bituminous Coals, or soft coals, vary in color from dark brown to dead black. They consist principally of fixed carbon, volatile matter or BITUMEN, and ash. The volatile matter, when heated, breaks down into gases, oils and tars, constituting by weight 25 to 35% of the American eastern bituminous and 30 to 45% of the mid-continental bituminous. The important divisions are the "coking" and the "non-coking" coals. Both burn with a yellowish flame and give off smoke. Coking coal has a tendency to fuse and swell in size during heating. Its high volatile content and richness in HYDROCARBONS make it valuable in the manufacture of coal gas. Non-coking coal burns freely without fusing and, therefore, is well adapted for burning on grates.

Cannel Coal is in a class between bituminous and sub-bituminous, but differs from and is considerably higher in hydrogen than either. Its name is derived from the fact that the coal burns like a candle. It is hard, dull black, easily broken and gives a large amount of gas when heated. It is valuable as an "enricher" in gas making.

Sub-bituminous Coal is black and shiny, has only a small trace of woody structure, contains less water and has a higher heat value than lignite. It differs from bituminous by the slacking it undergoes when exposed to weather. *Lignite* is the step between peat and sub-bituminous coal in the geological process of "coalification." *See* LIGNITE. *Peat* is organic matter in the first stages of conversion to coal. Its color varies from brown to black. It contains 70 to 85% of moisture when dredged or dug from bogs, and retains 15 to 30% when air dried. If dried artificially beyond this point, it must be used immediately or briquetted with a water-proof binder, otherwise it will reabsorb moisture.

Coke is made from coal either as a residue from the distillation of coal in gas manufacture or in specially designed coke ovens by external heating or partial combustion. *See also* COAL AS FUEL; PULVERIZED FUEL.

Wood is the representative of the organic substance from which coal is derived. It includes trees, small plants and mosses composed chemically of cellulose or of fibre and sap. It contains from 15 to 25% of moisture even when air-dried. *Charcoal* is made by heating wood in a closed vessel. Wood will yield approxi-

mately 18% charcoal and 82% volatile matter by weight at high temperature (2000° F.) and 68% charcoal and 32% volatile at low temperature (620° F.). The carbon content varies from 85 to 55%.

Bagasse is refuse sugar cane after the juice has been extracted and is largely used as fuel on sugar plantations. The composition is approximately 37 to 45% wood fiber, 9 to 10% of unextracted sucrose and 46 to 53% water.

Tanbark is the fibrous portion of "spent" tan, left from the ground bark employed in leather tanning. It is occasionally used as a fuel.

Liquid Fuel may be subdivided into crude PETROLEUM, its distillates, its residues (fuel oil, "dubbs" residue, etc.), ALCOHOL, COAL TARS and tar oils, PITCH, and colloidal fuel. The densities and fuel values of the principal oil fuels are as follows:

	Pounds per Gallon	B.t.u. per pound
Fuel oil	8.3 to 6.7	18,400 to 20,400
Gasoline (high-grade)	6.0	20,500
Gasoline (0.710 sp. gr.) .....	....	18,500
Kerosene (0.863 sp. gr.) .....	....	18,700
Kerosene	6.6	19,900
Denatured alcohol	6.8	11,600

Coal Tar is a by-product of the coking of coal. This black viscous liquid must be heated and strained before it can be used. It is lower in hydrogen and higher in carbon than petroleum, containing about 90% carbon and 5% hydrogen. The *tar oils* include CREOSOTE, ANTHRACENE and other residuum of coal distillation. Tar oils are less viscous than coal tar and can be handled much like other liquid fuels. *Pitch* is the final residuum of distillation of coal tar. Hard pitch contains approximately from 91 to 93% carbon and about 4½% hydrogen, running in volatile content between 65% and 70%. *Colloidal fuel* is an emulsion of solid powdered fuel and oil fuel and is fired with the same equipment used for oil burning. See also OIL FUEL.

Gaseous Fuels may be classified as NATURAL GAS, manufactured or illuminating gas, coke oven gas, blast furnace gas, producer gas and water gas. See also GAS MANUFACTURE. *Coke Oven gas* contains about 80% of hydrogen and hydro-carbons distilled off from coked coal. *Blast Furnace gas* contains about 60% nitrogen and quantities of CARBON MONOXIDE and CARBON DIOXIDE. It is formed in the process of reducing iron ore by the combustion of coke in an atmosphere lean in oxygen. *Producer gas* is generated by passing a current of air, or air and steam through a thick layer of incandescent coal surmounted by freshly charged coal. The solid fuel is thus converted into a combustible gas containing carbon monoxide, hydrogen and methane. See also GAS FUELS.

H. W. B.

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FUERTEVENTURA. See CANARY ISLANDS.

FUGITIVE SLAVE LAWS, two Acts of Congress for the enforcement of Article IV, Section 2, of the Constitution, providing for the return of "persons held to service or labor in one state, under the laws thereof" escaping into another state. The Act of Feb. 12, 1793, empowered the owner of a fugitive slave to apprehend the fugitive, take him before an appropriate magistrate, and, upon satisfactory proof of his ownership, to secure a warrant for removing the fugitive to the owner's domicile. The Act of Sept. 18, 1850, undertook to remedy the defects which hampered enforcement of the first act, and to overcome hostile legislation in the northern states. Since the Supreme Court had decided (*Prigg v. Pennsylvania*, 1842) that the duty of returning fugitive slaves could not be imposed upon state officials, the new statute imposed the obligation exclusively upon Federal officials; all warrants for the arrest or return of fugitives were to be issued by Federal commissioners or judges after a summary hearing of the complainant, or his attorney, and were to be executed by the Federal marshal under penalty of \$1,000 for disregarding such a warrant. The commissioner was to be paid \$10 if he issued a warrant, and a fee of half that amount upon refusal. The testimony of the alleged fugitive was inadmissible. Citizens were obligated under penalty to assist Federal officials in enforcing the law. The obvious partisanship of this act excited great resentment in the North; it proved unenforceable, and further estranged the sections.

FUGUE, derived from the Latin *fugere*, to flee, a species of musical imitation less rigid than CANON in construction but vying with it intellectually in the realm of COUNTERPOINT. Briefly described, it is a composition based on a single theme or phrase that is called the subject; the latter, first announced by a single unaccompanied voice or part, is imitated successively by all the other voices while the previous voices, having severally finished with the subject, proceed to what is called the counter-subject which in turn gives way to more or less free contrapuntal elaboration of the material developed. A fugue may have two or even more subjects, but the majority are content with one only.

Viewed ideally, the one-subject fugue is based on the successive imitations of that one subject and, transitionally, on its elaboration. However, according to scholastic custom, three separate elements are recognized: 1. the subject, 2. the answer, and 3. the counter-subject. The first, a theme usually running to 2, 4, or 8 measures, is announced in the tonic; the second is the same theme in the dominant; and the third is nearly any counter-melody which contrasts well and harmonizes properly with the subject. Actually there is very little justification for this distinction between subject and answer, save that it serves to mark the difference between a so-called real fugue and a tonal one; and between these two types of fugue there is only the difference between a subject which is exactly imitated in all its intervals and a subject which, for harmonic reasons, is very slightly modified in a few

intervals. As for the counter-subject itself, this fugal feature is often treated so freely that it belongs under the broad head of free counterpoint. However, as the foregoing divisions are technically recognized, they deserve brief mention.

As one of the great masters of counterpoint, **CHERUBINI**, remarked, "all that a good composer ought to know may find its place in a fugue. It should include all the artifices of counterpoint." Consequently it is not surprising to find such a supreme master as **J. S. BACH** making use of virtually every known artifice in the classical catalogue: namely, **INVERSION**, **AUGMENTATION**, **DIMINUTION**, **STRETTO**, and multiple counterpoint. Bach himself, it is to be regretted, failed to produce a treatise on this art in which he excelled; but he composed what might be called a tonal treatise on the whole art of fugal writing, namely, *The Art of Fugue*, which brilliantly illustrates, by actual performance, its varied principles; and the student can do no better than consult it.

FUJIWARA ERA, the first period in Japanese history when the real control of the government was exercised not by the emperor but by a powerful family. The system of dual authority developed out of political reforms in the latter half of the 7th century A.D. In 857 the head of the Fujiwara family became chancellor and the next year regent for his grandson the emperor. The dominance of the Fujiwaras continued until 1160, when the control passed to the Taira clan.

FUJIYAMA, the highest mountain of Japan, a magnificent snow-capped volcanic cone rising in solitary grandeur, 70 mi. southwest of Tokyo and visible in clear weather for a distance of about 100 mi. It has been quiescent since 1707. The summit rises to a height of 12,395 ft. The Japanese regard Fujiyama as a sacred mountain and pilgrimages are made to it every midsummer, hundreds of thousands of people ascending.

FUKUOKA, a city of Japan, capital of the prefecture of the same name, situated on the northwestern coast of Kyushu island, about 80 mi. northeast of **NAGASAKI**. Fukuoka is a rapidly growing commercial center, and has important manufactures of silk fabrics. Pop. 1931, 228,289.

FUKUSHIMA, a trade city in the prefecture of the same name on the main island of Japan, Hondo. It is 168 mi. from the capital, Tokyo, and is a center for business in raw silk and cocoons. The village streets show little foreign influence, although there are suburban tramways. Roofs of the homes have a picturesque temple flare. A small Shinto Shrine and figures of gods, several of Good Luck, adorn the city. Pop. 1925, 41,379.

FULGINIAE, a historic town of Umbria, central Italy, situated 15 mi. south of Nuceria, near the present-day Foligno. It stood 771 ft. above sea level. Although it has no ruins to mark its date, it was probably of relatively late origin, as it was without city ramparts. Fulginiae was important in imperial times on account of its location as a junction on the

new Via Flaminia, and was probably established by Flaminius.

FULGURITE. Lightning striking sand or porous rock, sometimes fuses it and forms irregular pipes of natural glass, called fulgurites, or lightning-tubes. Sand fulgurites $2\frac{1}{2}$ in. in diameter have been traced for many feet. Rock-fulgurites often take the form of a glassy enamel on lightning-struck stones. The most extraordinary development of rock-fulgurites, found also in the Alps, Pyrenees and Cascade Mountains, is on Little Ararat, in Armenia, where the entire summit is drilled with glassy tubes.

FULHAM PALACE, the residence of the bishops of London, in Fulham, London, on the manor of Fulham which has belonged to the bishops since 691. Of the present palace the two oldest portions are the courtyard, dating from the time of Henry VII (1457-1509), and the western quadrangle, built early in the 16th century by Bishop Fitzjames, containing the Great Hall, Muniment Room and Armour Room. The southern part of the palace was built by Bishop Terrick in 1765; the eastern portion by Bishop Howley in 1815. There is a fine chapel erected by Bishop Tait, 1867. The grounds of 28 acres were formerly surrounded by a moat, which was filled up, however, in 1921. Between the palace and the Thames is Bishop's Park, opened to the public in 1893.

FULLER, SIR GEORGE WARBURTON (1861-), Australian statesman, was born in Dunmore, New South Wales, Jan. 22, 1861. He was educated at Kiama Public School, St. Andrew's College and Sydney University, and has been a conspicuous figure in Australian public life for more than 40 years. He was minister for Home Affairs in the Deakin-Cook ministry (1909-10), chief secretary and acting premier for New South Wales (1916-20), and premier in 1925. He served on the tariff commission, organized to further Australian free trade. In 1919 he was created K.C.M.G.

FULLER, MELVILLE WESTON (1833-1910), American jurist, was born at Augusta, Me., Feb. 11, 1833. He was admitted to the bar in 1855, and the next year began law practice in Chicago. He was a member of the Illinois legislature during 1863-65. In 1888 he was appointed Chief Justice of the United States Supreme Court. In 1899 he was one of the arbitrators of the Venezuela-British Guiana boundary commission, and he was a member during 1900-10 of the Permanent Court of Arbitration at The Hague. He died at Sorrento, Me., July 4, 1910.

FULLER, SARAH MARGARET (1810-50), Marchioness Ossoli, American author and feminist, was born at Cambridgeport, Mass., May 3, 1810. Her father superintended her education, and she became a prodigy of learning. She taught school and associated with the most famous literary men of her day. She was, indeed, the chief feminine apostle of transcendental thought. Her principal publication was *Woman in the Nineteenth Century*, and she did much critical writing for the *New York Tribune*, and translated German works. She married the Marquis

Ossoli, and was drowned with her husband and child off Fire Island, N.Y., July 16, 1850.

FULLER, THOMAS (1608-61), English divine and antiquary, was born at Aldwinkle, Northamptonshire, England, in June 1608. Educated at Cambridge, he was curate of the Savoy, London, when the Civil War opened. In 1643 he joined Charles I at Oxford, but being a strong Royalist, he lost his preferments during the Commonwealth. With the Restoration he was made chaplain to Charles II. Of his several works on theology, morals, history and antiquities, the best-known is his *History of the Worthies of England*. Of the quaint humor of his style, Lamb has written, "his conceits are oftentimes deeply steeped in human feeling." Coleridge said he was "the most sensible and least prejudiced great man" of his age. He died in London, Aug. 16, 1661.

FULLER'S EARTH, an earthy form of KAOLIN or CLAY, having a high absorptive power and occurring as other clays. Fuller's earth is used for bleaching and clarifying oils and greases, especially in the petroleum industry, and in the manufacture of pigments and substitutes for talcum powder. It is produced in Florida, Texas, Georgia, California and Arkansas and in England.

FULLERTON, a city in Orange Co., southern California, situated 25 mi. southeast of Los Angeles. It is served by bus lines, the Pacific Electric Railway and three railroads. There is also an airport. Oil is produced within the city's boundaries. The local factories make glass, refrigeration machinery and oil well supplies. The retail trade in 1929 amounted to \$7,001,736. Citrus fruits, alligator pears and walnuts are the chief crops of the vicinity. The city is the seat of Fullerton District Junior College. Fullerton was incorporated in 1904. Pop. 1920, 4,415; 1930, 10,860.

FULMAR, a large, oceanic bird (*Fulmarus glacialis*) related to the albatrosses and petrels, abundant in the north Atlantic. It is somewhat smaller than the Herring gull with dark slaty gray plumage, long narrow wings and webbed feet. In flight it is powerful, seemingly tireless and exceedingly graceful, usually keeping well out to sea and visiting land only to breed. It nests in vast numbers on northern islets and lays a single large white egg which is highly prized for human food. Fulmars subsist chiefly upon fish, floating carrion and animal refuse thrown overboard by whalers and sealers, who call it the "Mollimoke," and it often flocks in thousands about a supply of food. Though very tame, if handled these birds will vomit an oily, ill-smelling fluid. Several closely related forms are found on the Pacific coast.

FULTON, ROBERT (1765-1815), American inventor and engineer, was born at Little Britain (now Fulton), Lancaster Co., Pa., in 1765. His early interests were artistic, and in 1786 he went to London to study painting. While there he met Francis Bridgewater, constructor of the Worsley-Manchester canal, who directed Fulton's interests to canal construction and navigation. Fulton obtained a patent covering a

canal-lock, and his inventions which followed included a new type of bridge, a saw for cutting marble, a dredger, a spinning-machine and a canal-boat. In 1797 he went to Paris to demonstrate a submarine and when the craft failed to operate he returned to England. In 1806 he returned to the United States and again undertook experiments in steam navigation, with which he had had little success on the Seine in 1803. From England he ordered a Watt and Boulton engine, which he installed in a vessel under construction at an East River shipyard. He was the first to make practical application of the principle and system of steam navigation, sailing up the Hudson from New York to Albany in the *Clermont* on Aug. 11-12, 1807. The trip required 32 hours. Fulton spent his remaining years perfecting plans for coast defenses. He died at New York City, Feb. 24, 1815.

FULTON, a city and county seat of Callaway Co., central Missouri, situated 26 mi. northeast of Jefferson City. Bus and truck lines and the Chicago and Alton Railroad afford transportation. There is an emergency airport. There are fire clay quarries and bituminous coal mines nearby and fire bricks are one of the chief articles of manufacture. Printing and the manufacture of shoes are also important industries. The surrounding country produces corn, wheat, oats and clover. Fulton is also an educational center, being the seat of Westminster College, William Woods College for Girls, a state hospital for the insane and Missouri School for the Deaf. The city was founded in 1825 by an act of the legislature. Pop. 1920, 5,595; 1930, 6,105.

FULTON, a city in Oswego Co., northern New York, situated on the Oswego River and Canal, 12 mi. south of Lake Ontario, 12 mi. southeast of Oswego; served by three railroads. Dairying and truck farming are the leading agricultural interests. The principal crop is lettuce. The city is a busy manufacturing center, turning out chocolate candy, paper containers, guns, serge cloth and various other commodities. In 1929 the value of the factory output was approximately \$26,000,000; the retail trade amounted to \$6,877,951. Near here in 1754 the British under Capt. John Bradstreet defeated the French and Indian forces which were more than twice as large and led by De Villiers. Bradstreet built a fort on the site of the city. The first settlers came about 1793. Fulton was incorporated in 1835; in 1902 it consolidated with Oswego Falls and was made a city. Pop. 1920, 13,043; 1930, 12,462.

FUMARoles, in regions of volcanic activity or recent VULCANISM, consist of holes or fissures in the ground from which there issue steam, sulphurous vapors and vapors containing hydrochloric acid, hydrogen sulphide and carbon dioxide. Sulphurous ones are often termed solfataras. On proceeding outward from a volcanic region, or in a region of dying vulcanism, there is a progressive change from hot, acid fumaroles to cooler carbon dioxide types. See also GEYSER.

FUMIGATION. See DISINFECTANTS.

FUMITORY, a genus (*Fumaria*) of delicate annuals of the fumitory family comprising about 40 species, native to the Old World. They are diffuse, erect or climbing herbs, with finely divided leaves and small flowers bearing a spur at the base. The common fumitory (*F. officinalis*) of Europe, with crimson-tipped purplish flowers, is sparingly introduced in North America. See also CLIMBING FUMITORY.

FUNCHAL, capital of the MADEIRA ISLANDS, situated on the south coast of Madeira Island. It presents a very picturesque appearance, with beautiful white-washed houses mounting in terraces up the slopes above the bay. The town contains a cathedral, an opera house, a museum and several other noteworthy buildings. Funchal is the industrial and commercial as well as administrative center of the Madeiras. Coal and wines are the principal exports. It is a popular health resort. Pop. about 20,000.

FUNCTION. One of the most valuable concepts in modern mathematics is the *function*. Inseparable from it is the idea of one or more independent variables, each capable of assuming all values in a given domain. The quantity y is said to be a function of the independent variable x or of the n independent variables $x_1, x_2, x_3, \dots, x_n$, if to every value or set of values which the independent variable or variables may assume there corresponds a value of y . For example, the distance traveled by a moving body is a function of several independent variables, viz., the time during which the motion takes place, the initial velocity, the accelerative force or forces, and the resistance. In general, to any variation of an independent variable corresponds a variation of the function; but this is not always true. For example, the weight of a human being may be measured at any instant of his life and is, therefore, a function of his age. During a certain period it may remain constant, but according to our definition it is still a function.

If the relation between the function y and the independent variable x can be expressed by means of an equation of the form

$$P_0 y^n + P_1 y^{n-1} + \dots + P_{n-1} y + P_n = 0,$$

where the P 's are polynomials in x , y is said to be an algebraic function of x . See TRIGONOMETRY; ELLIPTIC FUNCTIONS.

FUNCTIONS OF A REAL VARIABLE

In the theory of functions of a real variable attention is given to questions about the existence and properties of functions in real-number domains. Important topics proceeding in order from more comprehensive to more restricted classes of functions are: (1) existence of functions, (2) integrable functions, (3) continuous functions, (4) monogenic or differentiable functions, and (5) analytic functions. A subject which has received much attention is the approximation to given functions by means of infinite series of various kinds, such as (1) power series, (2) trigonometric series, (3) series of polynomials, (4) series of rational functions, and (5) series of con-

tinuous functions. A sufficient condition that the sum of a series of continuous functions shall itself be a continuous function is the uniform convergence of the series. A necessary and sufficient condition for the continuity of the sum is that the convergence be quasi-uniform. As first shown by Weierstrass, any function continuous in a given interval may be expressed as a uniformly convergent series of polynomials.

Of great importance in the modern theory of functions of a real variable is the measure of a point-set. With the assistance of this notion Riemann's criterion of integrability may be expressed thus: It is necessary and sufficient that the discontinuities of the integrand shall form a point-set of measure zero. A generalized theory of integration based upon the notion of measurable sets is due to Lebesgue.

In recent years there have been many researches in the theory of functions of a real variable. Results have been found upsetting some of the ideas that prevailed until quite recently. Examples have been given of continuous functions without derivatives. Among interesting discontinuous functions may be mentioned the totally discontinuous and the pointwise discontinuous. An example of the latter is a function continuous for every irrational value of the independent variable but discontinuous for rational values.

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FUNCTIONS OF A COMPLEX VARIABLE

The notion of function was extended to apply to complex variables during the 19th century. With this extension the domain of each variable became two-dimensional; and many earlier results, seen in a new light, assumed greater significance. To cite a very simple example, the theorem that between every two zero points of a polynomial there is a zero point of its derivative becomes in complex variables the one that any convex polygon which contains the zero points of a polynomial contains also the zero points of its derivatives. In a real number domain a function may have a first derivative without having a second derivative. If a function of a complex variable has a derivative at every point of a two-dimensional domain it must have an infinite number of successive derivatives.

In building up the theory of functions of a complex variable three great leaders were Cauchy (1789-1857), Riemann (1826-66), and Weierstrass (1815-97), to each of whom is due a certain line of development or method of exposition.

According to Weierstrass the fundamental notion is that of analytic function. A function $w = f(z)$ is analytic at a point $z = a$ if in the neighborhood of the point $z = a$ it is expressible in the form of a convergent power series,

$$w = a_0 + a_1(z-a) + a_2(z-a)^2 + \dots + a_n(z-a)^n + \dots$$

This series converges inside a circle whose center is the point $z = a$ and whose circumference passes through the nearest singular point, that is, the nearest point at which the function fails to have a derivative. If a function is analytic only within a certain region of the z -plane, every point of the boundary is a singular point.

One of the most interesting applications of the theory of functions of a complex variable is found in the problem of conformal representation. Let us represent the complex variable $z = x + yi$, where x and y are real and i is the imaginary unit, in one plane and another complex variable $w = u + vi$ in a second plane. Now consider any relation $w = f(z)$ where $f(z)$ is an analytic function. To every point (x, y) corresponds a point (u, v) ; and accordingly to every configuration in the z -plane corresponds a configuration in the w -plane. When such a correspondence is established between two planes we say that one plane is represented or mapped upon the other. Every analytic function $w = f(z)$ establishes a conformal representation, that is, a transformation such that any angle in the z -plane goes over into an angle of exactly the same size in the w -plane. Conversely every conformal representation of one plane upon another may be interpreted by means of one or the other of the relations $u + vi = f(x + yi)$, $u - vi = f(x + yi)$ where $f(x + yi)$ is an analytic function.

The theory of functions of a complex variable has many important applications to physics, particularly to hydrodynamics, heat, and electricity. See COMPLEX NUMBER.

T. S. F.

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FUNDAMENTAL POSITION, in musical HARMONY, the arrangement of the elements of a chord in which the lowest tone, called the bass, is identical with the root, or generator, from which the chord springs. The chord is called an INVERSION when the bass and the root are not identical. For example, the common chord C—E—G—C is said to be in fundamental position when the lowest tone is C, irrespective of the arrangement of the other tones; on the other hand, if the bass be E or G, the chord is not in fundamental position since the root, C, and the bass are not identical. Similarly, the seventh-chord G—B—D—F is said to be in fundamental position only when the bass is G, since G is the root of that seventh-chord. Since the unique elements of every chord in fundamental position follow one another at intervals of a third, the root of any chord is that tone which all the other tones follow at intervals of a third, reckoning always upward. Thus, C—E—G (common chord), C—E—G—B (chord of the seventh), C—E—G—B—D (chord of the ninth), and C—E—G—B—D—F (chord of the eleventh) are all chords based on tones separated by the interval of a third, and are therefore in fundamental position, C being the root and bass of all of them. The notion of a root or

generator is traced historically to JEAN PHILIPPE RAMEAU (1683-1764), a French musician who virtually founded the science of modern harmony; logically it is traced to the chord of nature or that natural succession of harmonics which is an important feature of acoustics.

FUNDAMENTAL TONE. See MUSICAL SOUNDS.

FUNDED DEBTS, in general a term covering any classes of BONDS issued in relatively large amounts and originally for a long term of years, and according to some orderly, prearranged plan. The term is most frequently applied in government finance, but is also applied to large corporations. Such debts are set over against the FLOATING DEBTS. The margins of size of the issues, of length of time for which they are to run, and the orderliness of the plan of payment are relative. The conditions, terms and rates used for funded debts are manifold and varied, so it is impossible to summarize them all. But two examples will illustrate the meaning. A state or a city may issue bonds for say \$5,000,000 in aggregate, each payable 40 years from date of issue, with interest at 4% per annum payable semi-annually. It would then, presumably, levy taxes each year thereafter in amounts calculated to be sufficient to pay the interest as it comes due every six months and also to provide a sinking fund to repay the principal when due. Such bonds would probably have to be approved by a vote of the people. Another illustration is afforded by the First Liberty Loan of the United States issued in 1917. This loan, authorized by Congress, was made by the sale of coupon bonds, bearing 3½% interest payable semi-annually. They could be paid by the government at its option after 1932 and were due in 1947.

C. C. P.

FUNDY, BAY OF, an inlet of the Atlantic Ocean, separating Nova Scotia from New Brunswick, Canada. From northeast to southwest its length is about 180 mi. with a breadth of from 30 to 50 mi., giving it an area of 6,300 sq. mi. At the upper extremity it branches into two forks, Chignecto Bay and Minas Channel which leads to Minas Basin. Passamaquoddy Bay indents the mainland coast near its mouth at the boundary between New Brunswick and the state of Maine. The St. John and St. Croix rivers flow into it from the west.

The bay is deep but navigation is dangerous because of the unusual tidal action. The tidal wave sweeps in from the ocean with a broad front and, as the shores of the bay draw together, its height increases until in Minas basin it attains 50 ft., said to be the highest tide in the world. Important harbors on the bay include St. John, St. Andrews, Digby and Annapolis.

FÜNFKIRCHEN, Hungary. See Pécs.

FUNGI. The fungi, more commonly known as mushrooms, mildews and molds, comprise a large group of chlorophyllless plants whose unit of structure usually consists of delicate threads, individually known as hyphæ, or collectively as mycelium or, in cultivated mushrooms, spawn. The absence of chloro-

phyll (leaf-green) means that these plants are unable to make their own food, as do chlorophyll bearing plants from inorganic substances, but must feed upon living or dead organic matter and are respectively either parasites or saprophytes.

These lowly forms of plant life are reproduced vegetatively by means of spawn or by especially formed reproductive bodies known as spores. The spores may be non-sexual or may be produced as a result of sexual conjugation. Conjugation in the fungi may take place through well-differentiated sex organs as in *Pyronema* or between hyphæ which are morphologically alike as in the common bread mold, *Mucor*. It has recently been shown that different species of fungi may be crossed (hybridized) as are the higher plants.

Since these plants are devoid of chlorophyll they do not require sunlight as do chlorophyll bearing plants but can grow and thrive in total darkness, in the ground, in caves or in trunks of trees. Only when they fruit do they come out into the sunlight and then, not because they require light, but in order that their spores may be set free and more widely disseminated by natural agencies, such as wind and insects.

Some fungi in their fruiting stages give off an odor resembling decaying animal or vegetable matter in order to attract insects which are made use of in the distribution of their spores. The spores are formed in great numbers, more than a billion being produced by a single mushroom, and are so minute that they are easily blown about and hence the fungi are much more widely distributed over the earth (cosmopolitan) than the higher seed bearing plants.

The fungi, represented by 50-75,000 species, are divided into four large groups, the Phycomycetes or filamentous fungi, commonly known as the lower fungi; the Basidiomycetes with their spores borne externally on protuberances known as basidia; and the Ascomycetes with their spores produced in closed sacs. In contrast with the Phycomycetes the last two groups are known as the higher fungi (*see also* Mushrooms). The fourth group, the Deuteromycetes, are sometimes called Imperfects since they are thought to represent stages in the life history of the higher fungi especially the Ascomycetes, many such connections having been already demonstrated.

Since many species of fungi live as parasites on other plants or animals, they are of extreme economic importance. The parasitic forms may have several phases in the life cycles and these may all occur on the same host in which case the fungus is said to be autoecious or the different phases may occur on entirely unrelated hosts when the fungus is heteroecious. Many of the so-called plant rusts are heteroecious.

Perhaps one of the best illustrations of a fungous parasite is the chestnut blight, *Endothia parasitica*. This fungus was apparently introduced into this country by accident from the Orient, although it was present in the country for a long time before its origin was even suspected. This obscure fungus has caused a loss of many millions of dollars in the few

years that it has been known here, having entirely destroyed the chestnut tree in those regions where it first appeared. It is much more virulent to our chestnut than to similar forms in its native land which is likely to be the case with introduced parasites.

One of the first of the heteroecious parasites studied was the common grain rust, *Puccinia graminis* which has its summer and winter phases on ordinary grain such as wheat and its spring phase on the barberry. The eradication of the barberry is helpful in control of this destructive parasite. Another recently introduced heteroecious rust is the white pine blister rust, *Cronartium ribicola*, which has its alternate phase on gooseberry or some other species of the genus *Ribes* or allied genera. This fungus is very destructive to the white pine but fortunately cannot travel from one pine tree to another but must cross by means of its alternate host. Therefore, if the plants of the various species of currants, gooseberries and their allies (*Ribes* sp.) are destroyed near white pine plantations the bridge is broken down and the spread of the parasite can be checked. This is the practical method employed to protect white pine plantations. A number of diseases of the human body are also caused by fungi, among them ringworm, mycosis of the ear and various other diseases.

F. J. S.

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FUNGICIDES are materials used to prevent the growth of fungi. Before modern commercial methods of food preservation were perfected certain preservatives notably benzoate of soda, were added to food products such as jams and catsups, to prevent spoiling and the formation of mold. When this practice became illegal through the passage of pure food laws, heat for longer periods or higher degrees was found even more effective.

The term fungicide, however, is most generally applied to those materials used to prevent the attacks of parasitic fungi on plants. These parasites include countless microscopic plants of low order, the smuts, rusts, mildews, molds and various other plant diseases, many of which unless prevented would make impossible the growing of fruits, vegetables and ornamental plants which they parasitize by feeding upon the sap or the tissues of their hosts, as the plants attacked are called. They are especially difficult to combat because their spores or seed bodies, minutely microscopic, are carried by the air often for miles, make unsuspected attacks and are not noticed until they have gained such headway that it is difficult or impossible to eradicate them.

Because of their insidious nature the control of plant diseases differs radically from that of insects. (*See* INSECTICIDES.) Whereas insects need be fought

only when actually found attacking plants, the only way to keep plants free from parasitic diseases is by preventing attacks. Therefore a protective coating of some fungicide must be applied prior to the expected arrival of the spores, so that when these alight they will be immediately destroyed. It is impossible to emphasize this point too strongly.

To be satisfactory a fungicide must destroy the parasite without injuring the host. It must adhere well to the tissues for protection against being washed off by rain, and for use on ripening fruit and ornamentals it must be colorless or readily removable. Although several materials meet one or more of these specifications, no one of them meets them all. Corrosive sublimate is so dangerous a poison its use is restricted to the destruction of disease spores on grain and potato tubers to be used for sowing or planting. Formalin is similarly used. Potassium sulphide and copper carbonate are effective and invisible on plants but are not permanent in wet weather. Iron and copper sulphates, although highly efficient, both injure foliage. Of these the one most used is copper sulphate mixed with quick lime to form Bordeaux mixture, the lime being added to prevent injury to foliage. Effective as a preventive of many plant diseases, lime is objectionable because it smears foliage and fruit and from the latter is not easily removed. Various combinations of lime and sulphur are equally effective but objectionable for the same reason. The so-called lime-sulphur wash is especially useful as a dormant spray or just before the buds of deciduous trees and shrubs begin to swell because it then not only destroys the germs and exposed mycelium or vegetative parts of plant disease but also kills various species of insects, mostly in the egg or newly hatched stage.

Various fungicides are applied in dust form with excellent results. Most notable of these are Bordeaux mixture and sulphur. The sticking power of these materials when finely pulverized is remarkable. They are presumed to act through becoming more or less soluble and adhesive if not also chemically changed through the absorption of moisture from the air.

Studies of plant diseases and insects have led to the publication of spraying schedules for free distribution by state agricultural colleges and experiment stations. These are so helpful that whoever grows plants should have the schedule that most nearly covers his locality.

Similar studies have also proved that fungicides should be applied to foliage in advance of rain storms or heavy dews because moisture is necessary for spore dissemination and germination of most diseases. Therefore weather forecasts should be studied daily throughout the growing season so advantage may be taken of approaching storms. Best advantage can be taken of such studies when dusting methods are practiced because these materials can be applied so much more rapidly than sprays that many acres may be dusted effectively between the time when the approach of a storm is noticed and the time when it arrives.

M. G. K.

FUNK, ISAAC KAUFFMAN (1839-1912), American publisher, was born at Clifton, O., Sept. 10, 1839. After graduating in 1861 at Wittenberg College he entered the ministry and held various pastorates including that of St. Matthews English Lutheran Church, Brooklyn. In 1878 he became a partner of A. W. Wagnalls in a publishing business later known as Funk & Wagnalls Company. As an expression of his interest in religious work and in prohibition, Funk founded and published *The Homiletic Review* in 1876, *The Missionary Review* in 1888, and *The Voice* in 1880. In 1889 he began publishing *The Literary Digest*. He was editor-in-chief of *The Standard Dictionary* in 1903 and in 1911-12 chairman of the editorial board of *The Jewish Encyclopedia*. His books include *The Widow's Mite* and *The Psychic Riddle*. He died at Montclair, N.J., Apr. 4, 1912.

FUNKIA, the name formerly given to a genus of low tufted plants of the lily family, several of which are commonly planted for their ornamental flowers and foliage. The group is now regarded as comprising the genus *Hosta*. See also *Hosta*.

FUNSTON, FREDERICK (1865-1917), American general, was born at New Carlisle, O., Nov. 9, 1865. After studying two years at the University of Kansas and being reporter on a newspaper, in 1891 he became botanist in the Department of Agriculture, accompanying Death Valley expedition, and in 1893 exploring Alaska and the Yukon, an expedition involving many hardships and dangers. In the Spanish-American War he went to the Philippines as colonel of the 20th Kansas Infantry, serving with distinction at Calumpit, for which he was promoted to brigadier-general of U.S. Volunteers. Later he organized and led the expedition which captured Aguinaldo, at Palawan, Mar. 23, 1901, for which exploit he was made brigadier-general of the U.S. Army. He was assigned command of the United States military occupation at Vera Cruz, Mexico, in 1914, and in 1916, as major-general, was given command of the forces mobilized on the Mexican border against General Villa. He died at San Antonio, Texas, Feb. 9, 1917.

FUR. The wearing of fur goes back beyond the dawn of history. Adam and Eve "wore garments of skins" and the covering of the Tabernacle was of fur. Queen Semiramis in the 21st century B.C. brought back 8,000 tiger skins from India. Wearing fur was once a mark of rank, and common people were forbidden its use in Europe during the Middle Ages. Fur has actually served as the coinage of several countries, including early settlements in America. The basic reason for its value is that it is warmer in proportion to its weight than any man-made fabric.

In this country, every state yields some sort of pelts, the Mississippi basin producing more fur than any other section of the world. The annual total catch in the United States is worth about \$60,000,000 while \$100,000,000 worth of raw fur is imported each year. The retail value of this fur exceeds half a bil-

lion dollars. There are 20,000 firms handling fur in the United States, and more than 2,000,000 people working in the industry. In New York City, where more than 80% of the fur used in the country is manufactured, the industry is fifth in economic importance. The leading raw fur markets of the world are London, St. Louis, Leipzig and New York.

Fur consists of three parts, the hide, the soft underfur and the long, stiff guard hairs, or overfur. Many animals have no fur, their coats being entirely hair. The best fur comes from the coldest climates, and is said to be prime when taken during the last of the cold weather, when the underfur, or pelage, is thickest and most glossy, and the hide toughest.

Aquatic animals have thicker fur on the underbody than on the back, while the opposite is true of land animals. To reveal the beauty of the underfur of aquatic animals, the guard hairs are plucked. The high cost of furs is due not only to the scarcity of some animals, but to the amount of handling necessary, a single sealskin going through 60 different operations, from raw skin to finished fur.

For information regarding the true fur of animals listed below, see other articles as indicated:

CHINCHILLA. Bastard chinchilla is a species with coarser, less valuable fur. French Chinchilla and other imitations are dyed rabbit or hare, or the natural chinchilla rabbit.

Civet cat, a black and white fur from the lesser skunk of the southern United States.

ERMINE. This delicate fur turns yellow with age. It is imitated by rabbit and cat.

Fisher, largest of the North American martens, closely allied to the true sable. This durable, warm fur is rich, dark brown with long black guard hairs.

Fitch, a European polecat having creamy yellow underfur with long black guard hairs. The best skins come from Germany and Russia.

Fox. Of fox furs, the most beautiful and rarest is the silver fox which is black, with silver tipped guard hairs. Pointed Fox is red fox, dyed black with white badger hairs sewed or cemented in the underfur. Next in value is the blue fox, the best of which comes from Alaska and the white or arctic fox, both of which are genus *alope*. Cross-fox is a mixture of black and red and is a variation of the red. Allied species, including the small Pampas fox of South America, occur in some southern countries. The Virginia, or gray, fox and the western coyote are cousins of the red fox. Their skins are usually dyed for pointed fox.

Hudson seal is sheared and dyed muskrat. The northern skins are best. High-grade Hudson seal can be distinguished from true fur seal only by experts. Sealine and near seal are sheared and dyed skins of either the large Belgian coney or Australian rabbit.

Kolinsky, an inferior sable of a naturally yellowish color, always dyed. Red sable, Siberian mink and Tartar sable are all dyed kolinsky.

Persian lamb, astrachan, broadtail and krimmer are the pelts of young karakul, the first three being black

and varying in tightness of curl. Krimmer is gray. Broadtail is the skin of stillborn lambs, but contrary to general opinion, the ewes are not sacrificed. It has a flat surface and the appearance of watered silk. "American broadtail" is lamb, sheared close, dyed and pressed.

Leopard is used for coats and for rugs. Leopardine and leopard kid are kidskins, dyed and stenciled.

Leopard cat comes from a smaller animal, native to the American southwest.

LYNX. Bay or red lynx is the dyed American bob or wildcat. Black lynx is dyed bobcat and Russian lynx dyed Siberian dog.

Marmot, a cheap fur usually dyed to imitate mink, sable or kolinsky, is sold as marmink or far eastern mink. Russian skins are the best, the American marmot or woodchuck being almost valueless.

Baum or pine marten, a dark brown fur closely resembling sable. The stone marten is a coarser fur, with light underbody. Japanese marten is smaller, lighter, and usually dyed to imitate sable. Hudson Bay sable is American marten, a fur fine enough to be sold by its real name.

MINK. Japanese weasel is often substituted for Japanese mink. Chinese mink is dyed weasel, and Florida mink dyed marmot. River mink is dyed muskrat.

MOLE. Moline is a trade name for sheared and dyed rabbit.

MUSKRAT. Silver Muskrat is the natural, silvery belly fur, also dyed beige, cocoa and taupe.

Nutria, the South American coypu rat, sometimes called South American beaver. It resembles beaver, but the underfur is shorter and scantier.

OPOSSUM. Australian opossum is the wallaby, a smoother fur than true opossum.

Pony. The best skins are from young colts of Central Asia. They are used natural or dyed, sometimes called Galyak, and some are as finely marked as broadtail.

RABBIT. Also called lapin.

SABLE. American sable is marten. Red sable and Tartar sable, kolinsky.

Alaska seal. Hudson Seal is sheared and dyed muskrat. Sealine is dyed coney or Australian rabbit.

SEA OTTER. Extremely rare, hardly a dozen new skins appearing annually. Single skins have sold for \$3,000.

SKUNK. Dyed, skunk is sold as Alaska sable, Black marten and under other trade names.

Souslik, a Russian ground squirrel, usually dyed beige, golden brown or platinum.

Squirrel, Gray. The best skins, from Russia, are used in the natural dark gray. Inferior and American skins are dyed beige, taupe and other shades.

Wolf, occasionally used natural, but more often dyed to imitate fox, which is silkier but wears less well. Manchurian wolf and Siberian black wolf are dyed Chinese dog.

Other furs commercially used include antelope, bear, chipmunk, dog, gazelle, goat, monkey, tiger, vicuna,

wolverine, and wombat. *See also* BADGER; BEAVER; OTTER; RACCOON; FUR SEAL; WEASEL. A. R. F.

FUR FARMING, the raising of fur-bearing animals in captivity for commercial purposes. Fur farming is increasing rapidly in North America and since the demand for furs threatens to exhaust the natural supply, fur farms may shortly be the principal means of supplying the more valuable pelts.

Rarest and most valuable of all furs, with the possible exception of the sea otter, is the black fox, a variety of the red. Naturally, therefore, this was one of the first fur-bearing animals raised in captivity. Since the best fur comes from the coldest climates, where animals' coats grow thicker, the first farms were on Prince Edward Island, still the center of the black fox industry. At first there was much speculation, companies being formed more to sell stocks than to raise foxes. However, farms that were sensibly organized and properly financed were very successful, so much so that fox farms were started elsewhere in Canada, the northern United States and Alaska. So great is the demand for breeding stock that selling young foxes is still the most profitable branch. The best animals are kept for breeding. Through careful selection, farm owners have established lines that are guaranteed to breed true black.

Almost all native fur-bearers are successfully bred. Next to fox, mink, muskrat and rabbit have proven most profitable. Rabbits are raised for breeding, for food and increasingly for fur. Mink have proved more easily raised than foxes, while muskrats are raised in enormous numbers on some of the protected marshes of the New Jersey and Maryland coasts.

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FURFURAL, an organic compound, having the formula $C_4H_3O \cdot CHO$, obtained from a great number of vegetable materials, such as bran, corn cobs, oat hulls, etc. It is known as furfuraldehyde, furfurol, pyromucic aldehyde. Although it was discovered by Dobereiner in 1832, only since 1922 has it been available in commercial quantities. It is now made from oat hulls, agitated with sulphuric acid in a current of steam which removes the furfural as it is formed.

Furfural has chemical properties similar to FORMALDEHYDE on the one hand and BENZALDEHYDE on the other. It undergoes many of the chemical reactions characteristic of these aldehydes, and also possesses its own peculiar properties, among which may be mentioned its sensitivity toward light, and its remarkable solvent power for cellulose esters and a large number of other organic compounds.

It has been extensively used in the manufacture of phenolaldehyde resins. As a selective solvent it has found application in the purification of wood rosin and crude anthracene. It is also used as a solvent for dye stuffs, in the tanning of leather, as a fungicide, preservative and herbicide.

Its derivatives are used as solvents, perfume constituents, preservatives, etc. F. N. P.

FURIES, in Roman mythology, goddesses of vengeance and punishers of crime; in Greek mythology, the EUMENIDES.

FURLONG, a measure of length equal to the eighth part of a mile, 40 rods, 220 yards or 201.17 meters, used in measuring land. The furlong originated as an indefinite unit of linear measure, being derived from the length of a furrow and hence, the length of a field.

FURNACE, ELECTRIC. *See* ELECTRIC FURNACE.

FURNACE, IRON BLAST. *See* IRON BLAST FURNACE.

FURNACE, OPEN-HEARTH. *See* OPEN-HEARTH PROCESS.

FURNACES, structures in which fuels are burned to produce heat for generating STEAM, for HEATING OF BUILDINGS, or for use in industrial or metallurgical process. Boiler furnaces have been developed to their present design from the simple square fire box of the Newcomen, Smeaton and Watt boilers. All early furnaces were very shallow as it was the belief that unless the fuel was very close to the surface to be heated, heat would escape and the process would be inefficient. It took more than a hundred years to bring out the principle that no actual flame must touch the boiler parts if high efficiency is to be obtained.

Modern furnaces have much more COMBUSTION space than the earlier ones and are usually designed on the basis of the heat liberated from the fuel. An allowance of about 1 cubic foot of furnace space for each 2 pounds of coal burned per hour has been considered good practice for a refractory furnace. When stokers are used it is possible to double the rate of firing, and rates up to 5 pounds of fuel per cubic foot of volume have proven highly efficient. With OIL FUEL, the rate is about double that with solid fuel, or 10 pounds per cubic feet.

When water-cooled FURNACE WALLS are provided, such as internally fired boilers of the Scotch marine or locomotive type, the rate of firing can be much greater, and rates up to 20 pounds of coal and 15 pounds of oil per cubic foot of volume have been burned successfully and efficiently under those conditions. Large modern boiler furnaces are now water-cooled through bare tubes, fin tubes or tubes covered with cast-iron or carborundum-faced blocks. These water-cooled furnaces have been most successful, and increasing amounts of fuel are burned with efficiency and at little upkeep cost.

Modern practice with boilers of reasonable size indicates a water-cooled furnace, the burning of fuel at reasonably high rates of combustion, reasonably high losses in forced and in induced-draft apparatus and very little excess air. When powdered coal is used, either a water-screened bottom is provided or the ashes are melted and collected in a slag pool at the bottom of the furnace. Where stokers are used, the size of the furnace is determined by the ability of the stoker to burn coal, and 50 to 60 pounds of coal per square foot of projected area with high efficiency have

been burned. Where highly volatile coals or anthracite coal is burned on a **STOKER**, ignition arches are usually employed, but the upkeep with this type of construction is high.

Modern furnace walls when built of **FIRE CLAY BRICK** require highly **REFRACTORY MATERIALS** or mechanical cooling by means of air vents or water tubes to keep down maintenance costs. G. A. O.

FURNACES, DOMESTIC HEATING, essentially stoves of special design surrounded by a sheet-metal or brick casing and provided with flues or pipes to circulate the air to and from the casing. A successful installation must have an unrestricted passage for the circulation of air throughout the system. The average domestic furnace has 20 square feet of heating surface to one square foot of grate area, heats the air to 175° F. and circulates it through the system by gravity. A water pan is often added to moisten the air. Hot-water and steam units are also used for domestic heating. See also **HEATING OF BUILDINGS**.

FURNACES, METALLURGICAL, structures wherein heat is generated for treating metals or their ores to alter their physical or chemical condition. They may be classified as to form and further as to use.

Shaft furnaces resemble stacks. Solid fuel and metal or ore charge enters at the top, heat is generated at the bottom by an air blast and the converted metal is extracted at the bottom. In this class are cupolas used for melting pig iron for castings; blast furnaces for converting iron ore to iron; for smelting copper, lead and other ores; roasters or kilns wherein sulphur and other elements are removed from ores by heating.

Reverberatory furnaces heat the charge not by direct contact with fuel, but by gaseous products of combustion. This class contains many furnace designs adapted for smelting, refining, melting and heat treating metals. Regenerative open hearth furnaces for melting steel are so classed. Special types for steel treating include continuous annealing, heat treating and **CARBURIZING** furnaces with car bottoms, chain, roller or sliding conveyors for carrying the work through.

Melting and **HEAT TREATING** of metals is conducted also in electric furnaces. High frequency induction furnaces and arc furnaces are used for melting metals with high melting point, and desistor type furnace for heat treating and melting easily fusible metals.

Muffle furnaces keep combustion gases away from the work being treated. Specially constructed furnaces are required for heating metals in special atmospheres. Furnaces for copper brazing in hydrogen, nitriding with ammonia, melting in a vacuum, and annealing in hydrogen or illuminating gas, are examples.

Pot and crucible furnaces consist of a pot or crucible surrounded by a combustion chamber or by electrical heating elements. Such furnaces are used for melting steel, brass, bronze, and soft metals and for heat treating steel in molten salts and metals.

F. O. CL.; A. L. Bo.

FURNACE WALLS, vertical or inclined walls surrounding a **FURNACE**. Their purpose is to confine the heat within the furnace and deliver it to a superimposed **BOILER** or other heat-absorbing apparatus. All early furnace walls were built of firebrick or other **REFRACTORY MATERIALS**. Later, steel was used and water-cooled walls were introduced. The locomotive and the internally fired marine boilers were among the first to use water-cooled furnaces, and up to about 1920 practically all stationary furnaces were built with refractory walls.

The introduction of pulverized coal brought about the development of *cooled* furnace walls. Because of the erosive or fluxing effect of molted coal ash, the destruction of refractory walls was rapid. By making the furnaces larger and reducing the rate of combustion the destructive effect was reduced, but the larger furnaces were too costly. Placing water tubes across the bottom of the furnace cooled the grates sufficiently to prevent the ash from melting but did not protect the side or rear walls. Next it was found that by keeping the inner face of the brick below certain temperatures, the attack of the molten ash was retarded. To that end air channels were provided in the walls so that the furnace would draw air through them for combustion. This was found to be helpful but only to a small extent. However, the trend toward higher capacities and the increasing use of air **PRE-HEATERS** with the resulting higher furnace temperatures, indicated the necessity of better means of reducing the cost of furnace maintenance, and spaced water tubes were installed on the rear and side walls. Furnace-wall life was increased, but combustion rates quickly equalled and surpassed those safe for the spaced-tube wall. Tubes were then placed closer together and the spaces between them closed by narrow fins electrically welded to the tubes, thus presenting a completely metal water-cooled wall. See also **HEAT EXCHANGE EQUIPMENT**.

Armored or protected tubes of several types followed. Among these are tubes having cast-iron blocks cast on the tubes by a process that fused the steel of the tube with the cast-iron. In other types cast-iron or steel blocks are closely fitted to the tubes and held in place by suitable clamps. A third type has bored cast-iron rings shrunk onto the tubes. In all of the above types, the blocks face the fire. A fourth type is the individual refractory covered tube, known as the stud tube construction. A series of studs or spines are attached to the outer wall of the tube by spot welding, so that they extend radially all around. These spines, or studs, act as holders for a plastic refractory which has been used with marked success, on screening tubes for slagging furnaces which burn pulverized coal.

The major purpose of a water-cooled wall is the reduction or elimination of maintenance, and among its incidental advantages is the reduction of the temperature of the gas leaving the furnace. This reduces the accumulation of scale on the lower boiler tubes.

J. VAN B.; K. T.

FURNESS, HORACE HOWARD (1833-1912), American scholar, was born in Philadelphia, Pa.,

Nov. 2, 1833, and studied at Harvard and the University of Halle. He practiced law for a time, then devoted his energies to the Shakespearean research for which he is noted. After summarizing the conclusions of the outstanding authorities on this subject, he published the *Variorum Shakespeare*, beginning with *Romeo and Juliet* in 1871 and ending with *Cymbeline*, 1913. He was awarded honorary degrees by Columbia, Yale and Harvard. Furness died at Wallingford, Pa., Aug. 13, 1912.

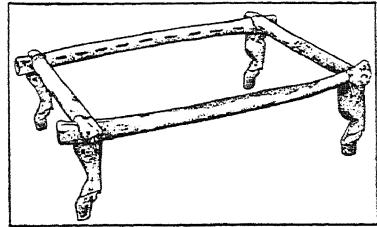
FURNESS ABBEY, a ruined structure in Lancashire, England, in a picturesque, wooded valley about 70 mi. north of Liverpool. Built in 1127 for the Benedictine monks of Savigny, Stephen granted its abbot absolute overlordship of Furness town, the Abbey subsequently becoming one of the wealthiest in England in spite of 13th century Scottish raids. In 1537 the abbot, accused of irregularities, ceded the foundation to the Crown and it became part of the Duchy of Lancashire. The beautiful red sandstone ruins ranging from Transitional Norman to Early English, are extensive, and in the infirmary chapel, among 12th century effigies, include two of knights in flat-topped helmets believed to be the oldest in England.

FURNITURE, originally the name for all movable articles in a household. In the modern sense the term is restricted to the principal pieces constructed of wood or metal, which may be upholstered with brocade, tapestry, damask, or other material, and are used for purposes of comfort and decoration in living quarters. In addition to its decorative importance, furniture has a special historical interest for mankind. Its successive periods are a fairly accurate index to the manners and tastes of people in corresponding epochs. The unearthed remains of an Assyrian chair or an Egyptian bed are more eloquent of the past, in general, than a petrified skeleton, and historians are indebted to many such relics of furniture for their reconstructions of the social life of other times.

Even in the modern definition of a wooden or metal frame in which to sit, lie, rest or to place things on or in, furniture has a venerable history. It does not begin, however, with primitive man, for he squatted and slept on the ground. Nor may an account of furniture begin with his successor, the nomad, for the wandering tribesman carried only the lightest articles. The first peoples to substitute floors for the ground and to settle in established communities instead of camps, were the first to devise furniture. The Assyrians and the Egyptians were such peoples, and so doubtless were the Chinese.

Egyptian. The Egyptians were ingenious to a high degree. There are ample murals in existence which picture their chairs, stools, thrones and couches. A fair example of early Egyptian furniture is a chair in the Metropolitan Museum, New York City, dating from at least 1500 B.C. It is constructed of wood, and legs and back are reinforced with angle-braces made of forked branches. The chair is 23 in. high; the seat is 17 in. by 18½ in. raised 7½ in. from the floor;

the back is made of wooden panels, set ¼ in. apart; wooden pegs hold the piece together. The Metropolitan Museum also exhibits an Egyptian couch of about 3400 B.C. which is 1 ft. high, 26 in. wide and 63 in. long; it is supported by carved bull's legs. Decoration and the use of fabrics, especially in the

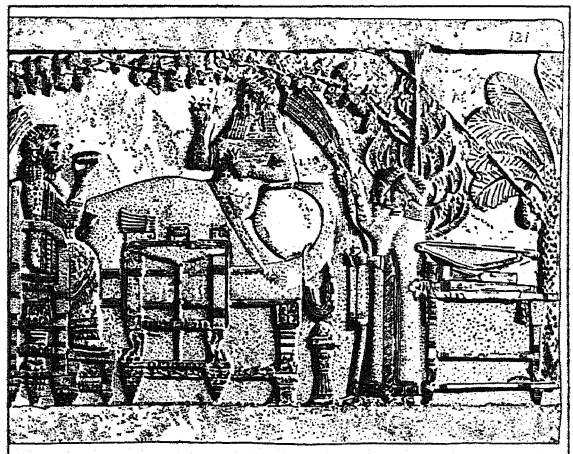


COURTESY M. M. OF ART

WOODEN EGYPTIAN COUCH FROM
FARKHAR. ABOUT 3400 B.C.

seats of chairs, were a logical evolution; tables, boxes, chests and coffer were devised by the early Egyptians to answer obvious needs. Later their dynastic civilization lent itself admirably to the production of richly carved and decorated furniture, for slave labor was often skilled labor. Chased gold was commonly used in furniture for Tut-ankh-amen, as the Carter excavations disclosed in 1923.

Assyrian. An unmistakable key to the Assyrian temperament is the martial character in the decoration of the furniture of this race. Where the Egyptian pieces are highly polished and relatively subtle in design, the Assyrian furniture is more often forthright and realistic in its embellishment. Thus King Guden (3000 B.C.) is shown seated on a rude stool; King Assurnasirpal (880 B.C.) has a backless bronze throne



COURTESY METROPOLITAN MUSEUM OF ART

ASSYRIAN FURNITURE OF THE 7TH CENTURY B.C.
King Ashur-Bani-Pal banqueting in garden with the Queen

and a small table constructed to carry a sword, bow and quiver. Apparently metal was widely used in early Assyrian furniture. It is significant that the utilitarian note in Assyrian furniture seems to prevail roughly up to the second empire (746 B.C.); thereafter there is, in comparison, an almost effete quality in

Assyrian decoration. Furniture was made of imported Indian walnut, teak and rosewood, and delicately inlaid with ivory and ebony. The empire fell to the Scythians in the 6th century B.C., and more than one historian has attributed this defeat to a relative sophistication which is apparent in the design of late Assyrian furniture.

Greek. The Greeks were sparing in the use of furniture, reflecting the simplicity of their life and their emphasis on exercise. But like all their art, the furniture they did design was exquisite in proportion. Instead of the animal terminals and heads which their predecessors reproduced in furniture, the Greeks turned their woods in natural curves. They achieved grace in chairs, stools, tables and couches by increasing the height. A common armchair had a straight back and legs, and its height made a footstool necessary. The humbler *diphros* was a four-legged stool, which sometimes folded up like a modern camp seat. The



GREEK CHAIR OF
ABOUT 450 B.C.

klismos was built to fit the body, with the front legs curved forward, and the back legs rearward. Boxes and chests were decorated with mythological scenes.

Roman. The first distinctly Roman furniture was copied from the Greek model, but as Roman life became more distinctive and complicated, it evolved its own decoration. The *triclinia* or common couch was an oblong framework over which girths were strung to support a mattress filled with wool, feathers or straw. The frame was frequently inlaid. The *lectus cubicularis* or bed was similar in design, but slightly higher. Tables were often supported on columns of marble and ivory. Ivory was also used to make the *curule* chairs or state seats. Candelabra were often inlaid with silver. But in general the Roman interior was severe until Caesarian conquests led to a passion for luxury, which in furniture demanded inlay work with boxwood, ebony, cherry, terebinth, stained horn, gold, silver and precious stones. The peak of this elaboration in furniture coincides with the fall of Rome in the 5th century.

The Middle Ages. As the medieval era was a period of stagnancy in other fields, so was it in furniture. Constant wars in Europe necessitated rapid transport, and furniture was a burden. Such as it was, the chief influence on furniture in the early Middle Ages was the Church, which strove to perpetuate Roman design. In the later Middle Ages the

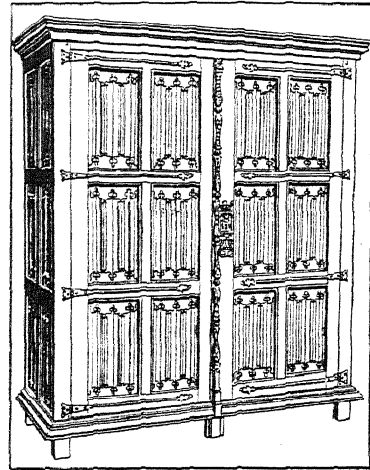


COURTESY M. M. OF ART

GREEK COUCH OF THE 4TH
CENTURY B.C.

Visit of Thetis to Hephaestus

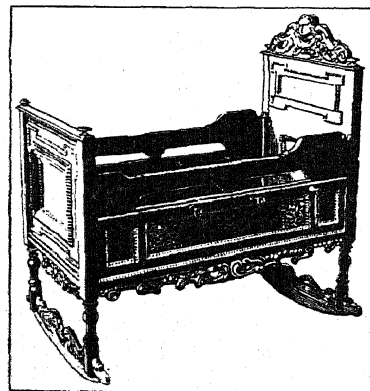
Gothic style influenced the design of chests, settles, and even altars and choir stalls. The Gothic arch, more properly the Romanesque arch, began to appear as a common motif in the design and structure of



COURTESY M. M. OF ART

FRENCH OAK CABINET OF THE LATE
15TH CENTURY

chairs, long-tables, beds, couches, chests and coffers. Toward the end of the 11th century the *armoire* and a variety of cupboards came into use, the sideboard with Moorish carving was common in Spain, and wood carving was flourishing in Germany. By the 15th century the long period of stagnation in furni-



COURTESY M. M. OF ART

17TH CENTURY DUTCH CRADLE
Walnut with fancy mouldings, and three
handles on each side

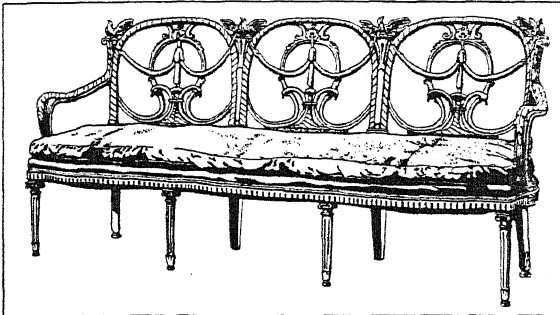
ture design came to an end and furniture began to be transformed by the passionate interest in decoration which was one of the characteristics of the RENAISSANCE.

Renaissance to Modern Times. The evolution of furniture in the chief countries from the Renaissance to the present day is briefly treated in the following outline.

Italian Furniture. The Italians happily combined the austere lines of ecclesiastical furniture with grace-

ful curves and a rich upholstery hitherto unknown. But wood carving and painting were the chief glories of the new pieces. Venice became the center of the multiple inlay work known as *marquetry*. Chests or *cassoni* were magnificently carved in high relief, gilded, and the top painted in colors. The backs of chairs and canopied beds were high, elaborately embellished. The Italian Renaissance table was a long rectangle, supported at either end by flat, carved standards, often in the manner of Roman garden tables. The chair seats were upholstered in brilliant velvet and embroidery, and the legs, running up to

classic simplicity. On chairs the armrests were set obliquely to provide room for the crinolines. Louis XVI furniture was a happy return to classic slenderness; its chief pieces were light tables, love seats, narrow sofas with stuffed cushions, all of which before the Revolution degenerated when ornamented with urns, lion-



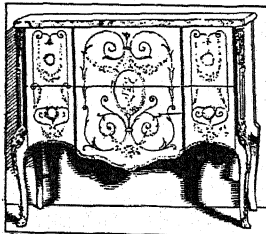
COURTESY METROPOLITAN MUSEUM OF ART

PAINTED ITALIAN SETTEE
Late 18th century

the flat arms, were sometimes studded with gilt nails. Bookcases, cabinets and desks were made for the wealthy. In the late 16th century Italian furniture suffered somewhat from the florid excesses of the Baroque school. But the fine design of the early Renaissance so impressed itself on the Italian mind that, unlike most other countries, the nation's criterion in furniture has not fundamentally changed since that time. The best Italian pieces to-day are reproductions of 15th century Italian Renaissance.

French Furniture. The series of French incursions into Italy beginning with the early 16th century inevitably influenced furniture in the northern country. But unlike Italy, France has progressed through a number of distinctive periods. The adoption of

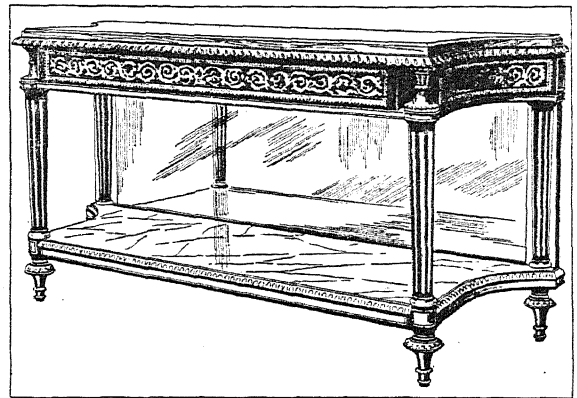
Italian Renaissance was followed by the Louis XIV style. The early pompousness of this epoch gave way to delicate work characterized by fluted columns in chairs and tables. The graceful designs of the Gobelín furniture tapestries astonished all Europe. In the Louis XV style furniture became smaller as large rooms went out of vogue.



COURTESY JOHN WIDDICOMB CO.

COMMODOE OF THE LOUIS XVI
PERIOD

Paris designers then concentrated on ornamentation; tables, chairs, cabinets and beds abounded in carved or painted cupids, doves, lambs and shepherds. Similar "Pretty" *motifs*, presented in a wealth of gilt and silver, were the characteristics of the French rococo style until 1750, when Madame Pompadour led a return to



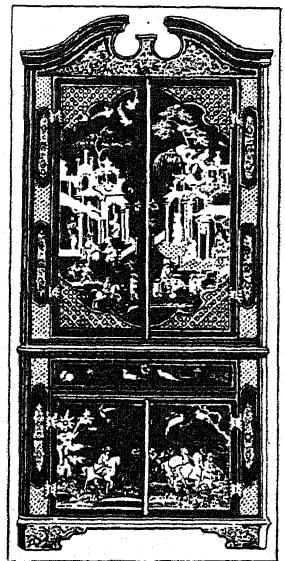
COURTESY METROPOLITAN MUSEUM OF ART

FRENCH CONSOLE OF THE 18TH CENTURY
Mahogany with ormolu decoration

heads, medallions, ribbons and the like. The Napoleonic Empire period produced little of a meritorious nature, for it was in most manifestations a burly adaptation of the Roman. "Trophy" decorations prevailed, "Winged Victories" and the eagle were carved on many typical pieces, and the bold "N" was heavily imposed wherever there was space. After 1825 the Empire style was extinct. French furniture designers strove to return to simplicity, and to a model combining the best elements of its several periods. Save for fadist movements, like the *art moderne motifs* of angles and plane surfaces, especially fashionable since 1925, the best French designers are still seeking an ideal adaptation of past styles.

German Furniture. The chief German contributions to furniture were the arts of wood-carving and cabinet-making. In other respects, the nation followed the lead of France.

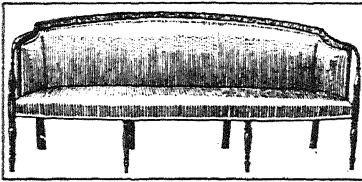
English Furniture. With insular variations, English furniture followed the main trends of French design, save in respect to "Manor" furniture, where space permitted generous proportions. Tudor style was a combination of Renaissance with early French Gothic. Tables were long and narrow and often had footboards. The coffer was the characteristic



COURTESY W. M. OF ART

ENGLISH CORNER CABINET IN
BLACK LACQUER AND GILT,
1725-1730

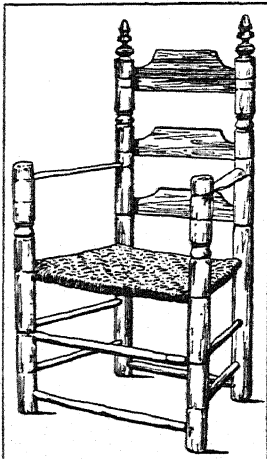
piece of furniture, serving as a night bed and a day couch. The Elizabethan period ushered in a profusion of chairs with heavy stretchers and paneled backs. Posters were often spindle-shaped, or "turned," and



COURTESY M. M. OF ART

AMERICAN SOFA, COLONIAL PERIOD,
SHOWING SHERATON INFLUENCE

nail head and strapwork were common ornamentation. The Jacobean or early Stuart period was typified by bad carving, but good panel work. Chairs returned to straight legs, and the so-called drop tables were an innovation. After the return of Charles II in 1660, England copied the ornate style of Louis XIV. The Queen Anne period produced furniture which combined comfort with grace, such as the balanced "Windsor" chair, but it also gave birth to the "claw-and-hammer" decoration on leg bottoms. The high-



COURTESY M. M. OF ART

SLAT BACK COLONIAL CHAIR

boy and lowboy were commodious chests of drawers mounted on legs. The Georgian period in furniture was chiefly famous for the designs of THOMAS CHIPPENDALE, ROBERT ADAM and his brothers, GEORGE HEPPELWHITE and THOMAS SHERATON. Mahogany supplanted walnut. This era produced a variety of articles ranging from sideboards and chairs to small bedroom pieces, much of it characterized by extreme grace, highly finished woodwork and by a restraint in upholstery fabrics and shades. In the 19th century furniture suffered

from the introduction of machinery, and the Victorian period was given over to massive grotesqueries which marked the lowest point in furniture development. About 1860 PRE-RAPHAELITISM led to an unrestrained vogue for collecting "periods," which was an improvement over the Victorian atrocities, but led to a hodge-podge of designs. Not until the 20th century did England emerge from this uninspired period of sham medievalism.

American Colonial. Furniture in the American colonies logically followed the English, Dutch and Swedish models. Georgian pieces were common, but the finest colonial furniture was the Chippendale, Heppelwhite and Sheraton adaptations. Sheraton doubtless inspired the graceful curved, fluted legs and lyre-ends designed by DUNCAN PHYFE of New York.

The only strictly native piece was the rocking-chair, a development of the colonial cradle. A Victorian adaptation that led to excesses, notably with green plush upholstery, and which was even more disproportionate than the English design, prevailed in the United States until the 20th century. The present-day reproduction of fine furniture has grown into an important industry in this country. As in France, modernistic furniture has enjoyed a vogue in urban communities. See also INTERIOR DECORATION.

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FURNITURE INDUSTRY, UNITED STATES. This industry embraces establishments devoted to the manufacture of furniture made of wood, metal, fiber, reed, rattan and willow. The products are comprised in four general classes: (1) household furniture, (2) furniture and fixtures for stores and offices, (3) furniture for public buildings, and (4) professional furniture. To the total furniture output for 1929 the first group contributed 72.3%; the second, 21.4%; the third, 4.6%, and the fourth, 1.7%. Wood was used in making 85.5% of the total production, metal for 12.4%, and other materials for 2.1%.

FURNITURE MANUFACTURES, U.S., 1899-1929

Year	No. Establishments	Wage Earners	Wages \$	Value of Products \$
1899	1,929	88,964	36,443,360	128,264,001
1904	2,637	113,486	51,655,685	176,615,364
1909	3,188	127,088	65,047,325	236,942,836
1914	3,338	130,423	73,401,611	271,610,464
1919	3,279	140,252	143,152,217	579,906,396
1925	3,239	181,016	225,297,743	868,719,971
1929	3,778	193,399	242,832,096	948,116,358

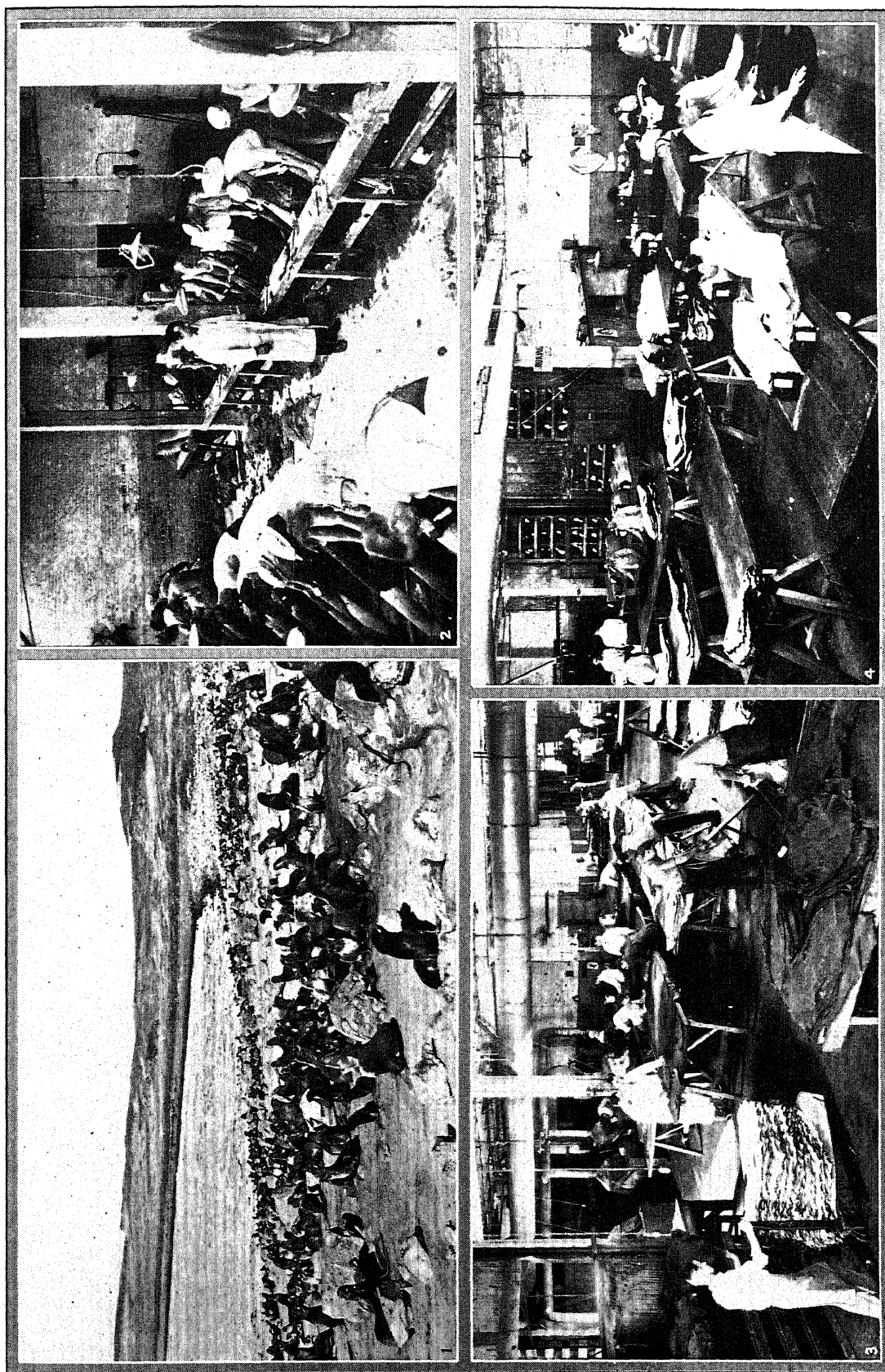
FURNIVALL, FREDERICK JAMES (1825-1910), English philologist, was born at Egham, Surrey, Feb. 4, 1825, and educated at Cambridge. He made an exhaustive study of early English literature and published a valuable edition of *Chaucer's Canterbury Tales*, the *Century Shakespeare* and other works on philology. He was one of the first editors of the *Oxford New English Dictionary*. Furnivall died July 2, 1910.

FUR RANCHER. See FUR FARMING.

FUR SEAL (*Callorhinus alascanus*), also called the sea bear, is a species of sea lion. Its soft, dark brown fur differs greatly from the hairlike coat of the true seal. The fur seal is an aquatic pinniped mammal, the male, about 6 ft. long, weighing up to 500 lbs. The smaller female weighs about 80 lbs. Each male has a harem of from 20 to 50 females.

Until the middle of the 19th century, there were herds of fur seals on the pelagic islands off the Southern Hemisphere. These are now almost extinct. The largest herd of northern fur seals is found on the Pribilof Islands off Alaska. Though in 1880 there were over 2,500,000 fur seals on these islands alone, 20 years later their extinction seemed inevitable. The

FUR SEAL



COURTESY UNITED STATES DEPT. OF COMMERCE, BUREAU OF FISHERIES

PREPARING SEAL SKINS FOR THE FUR MARKET

1. Herd of fur seals on the Pribilof Islands, Alaska.
2. Dehairing or removing outer guard hairs of Alaska fur seal pelts.
3. Dressing the pelts.
4. Final inspection of finished skins. Photographs 2, 3 and 4 were taken in St. Louis, Missouri, one of the largest fur markets in the United States.

United States and Russia agreed to protect the islands, but illegal shooting of the seals in the water slaughtered millions. Finally in 1911 an agreement between the United States, Russia, Great Britain and Japan ended pelagic sealing and prevented extermination. The herds now number over a million individuals and several thousand skins are taken annually under government supervision, each interested nation receiving its quota.

During June and July, the rock-strewn breeding beaches are covered with immense numbers of fur seals. The bulls arrive in May, the cows early in June, a single young being born two days after the female comes ashore. The pups weigh about 10 lbs. at birth and cannot swim. While nursing them and teaching them to feed, the females go out to sea to feed, but the bulls fast until they leave in August. The female and the young migrate south in late fall, formerly going as far as California. The animal's chief food is squids and fish, including pollock, cod and salmon.

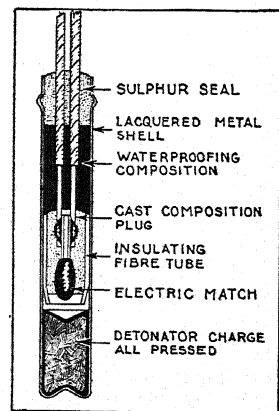
FÜRTH, a city of Bavaria, 6 mi. northwest of Nuremberg, with which it is connected by railways, and situated on the Ludwigs Canal. It has a 14th century Gothic church and fine modern buildings. Fürth is an important city in trade and industry and rivals Nuremberg in the manufacture of "Nuremberg Goods." Mirrors, toys, pencils and machines are the principal manufactures. First mentioned in 1007, it was under the burgraff of Nuremberg, fell to Prussia in 1792, and to Bavaria in 1806. The city has grown by annexing its former ten suburbs. Pop. 1925, 74,195.

FURZE (*Ulex europaeus*), called also gorse and whin, an intensely spiny shrub of the pea family, native to the Old World, widely cultivated as an orna-

mental and extensively naturalized in various regions. It is a much branched bushy plant, 2 to 4 ft. high, with grooved branchlets, very narrow or scale-like leaves and bright yellow, fragrant, pealike flowers crowded near the ends of the branchlets. It blooms in spring and often again in autumn; in California it continues in flower almost throughout the year.

FUSAN-FU. See **PUSAN.**

FUSE, as used in **BLASTING**, a long core of black powder wrapped in hemp, jute or cotton fibers; also



CROSS SECTION OF AN ELECTRIC FUSE

a pair of small insulated copper wires connected by a platinum filament and joined to a source of electrical current. In the electric fuse the filament becomes hot when current is passed through it, and ignites the explosive; in the powder fuse the fuse burns, the flame igniting the explosive.

The fuse used in low-current electrical installations consists of a metal alloy designed to melt when the current exceeds a predetermined value. The "blowing" of the fuse opens the circuit, thereby protecting the electrical installation from damage due to excess current.

FUSED SILICA, or fused quartz, the translucent product made by fusing sand in an electric furnace. It is satisfactory for the construction of some physical and chemical apparatus. The clear, glass-like fused silica, which has a much wider field of applications, is made by melting crystal **QUARTZ** in a vacuum electric furnace. Fused silica of either type is characterized by its high melting point and its small coefficient of expansion. For a given range of temperature it expands less than one-tenth as much as glass. This permits the silica to stand rapid changes of temperature without breaking, and makes its use advantageous where permanence of form with change of temperature is desirable. See also **SILICON**. I. C. G.

BIBLIOGRAPHY.—R. B. Sosman, *The Properties of Silica*, 1927.

FUSEL OIL, an oily liquid often present as an impurity in improperly distilled alcoholic liquors. It has an unpleasant odor, and if taken internally is injurious to health. It consists of alcohols, acids and esters, the principal constituents being **AMYL ALCOHOLS**.

FUSHUN COAL MINES, the principal Japanese-controlled coal mines in Manchuria about 30 mi. east of Shenyang (Mukden). The coal deposits in the Fushun area total around 1,000,000,000 tons, in approximately 23 sq. mi. The seam is exceptionally thick, averaging 130 ft. and increasing to 430 ft. in places. The coal is bituminous, and not especially suitable for coking. The mines were worked on a small scale as long as 600 years ago. The Russians secured control as part of the concession (1896) to build the **CHINESE EASTERN RAILWAY**, but did little to develop coal production. The Japanese acquired control as a result of the **RUSO-JAPANESE WAR**, and promptly pushed development. The production in 1930 was approximately 7,500,000 tons. Owing in part to the fact that a large part of the coal is mined by open cutting (the Fushun open-cut pit is the largest in the world), production costs are lower than at any other coal mine in the Far East, averaging from 60 to 70 cents per ton. On top of the coal at Fushun is a layer of oil shale. The Japanese have developed a process of extracting the oil by distillation, by which it is estimated that around 300,000,000 tons of crude oil can be recovered from the oil shale deposits.

FUSIBLE ALLOYS, alloys which melt at comparatively low temperatures, generally composed of bismuth, lead and tin. They are used in valves in water sprinkling systems installed in factories and warehouses for putting out fires, in safety plugs in boilers, etc. Many fusible alloys expand on cooling and are used where very sharp castings are desired. See also **TYPE METAL**.

FUSION, a coalition of parties or factions, usually for the purpose of defeating some stronger party in a particular election. Thus, in New York City, where the Tammany Democrats are predominant, the Republicans have at times combined with the independent Democrats, winning their support by the concession of certain places on the fusion ticket. This situation has occurred several times in presidential elections.

FUSION, the process by which a substance in the solid state is converted to the liquid state upon the addition of a certain amount of heat after the melting point is reached. Fusion is explained as an increase in the kinetic energy of the atoms such that their amplitudes of vibration increase to the point where the atoms approach one another and influence one another so strongly that they fail to return to their original positions, thus breaking down the solid. The *heat of fusion* is the heat required to produce fusion after the melting point is reached. *See also* SOLID STATE, THEORY OF.

FUST, JOHANN, a German printer of Maintz, who in 1450 and again two years later advanced money to Johann GUTENBERG, then beginning his first printing at Maintz. In 1455 Fust and Gutenberg for some breach of the latter's contract, and apparently won Gutenberg's type and press. Shortly after he entered into partnership with his son-in-law, Peter Schöffer and began printing, their first work being a Psalter issued in 1457. They printed, among other works, an edition of the Bible in 1462, and in 1465 the first printed classical work, Cicero's *De Officiis*. Fust appears to have died of the plague at Paris in 1466 leaving his press to Schöffer.

FUSTEL DE COULANGES, NUMA DENIS (1830-89), French historian, was born in Paris on Mar. 18, 1830. He left the École Normale in 1853 to spend two years at the French school in Athens. From 1860-70 he was professor at the University of Strasbourg, then at the École Normale, and finally at the University of Paris. As a historian, he broke away from the prevailing French tendency to make history a special plea for national or party bias, even treating dispassionately Germany's annexation of Alsace-Lorraine. In 1864 he published his *La Cité antique*. In the *Histoire des Institutions politiques de l'ancienne*

France, the first volume of which appeared in 1875, he maintained that the Germans had entered Gaul as colonists rather than as conquerors; that they had contributed little or nothing new, and finally amalgamated with the Gallo-Roman population. He regarded history as an objective science based on the study of original sources; in it he saw only institutions, not personalities. He died at Massy on Sept. 12, 1889. W. I. B.

FUSTIC (*Chlorophora tinctoria*), a large tree of the mulberry family growing in the West Indies and tropical South America. The strong, bright yellow wood, known as yellow wood or old fustic and sometimes utilized for lumber, yields a yellow dye used in the arts and by dyers to produce various shades of yellow, brown, olive and green. Young fustic is a yellow dyestuff obtained from the Venetian sumach (*Rhus Cotinus*).

FUSULINA LIMESTONE, a rock made up largely or wholly of the calcareous shells of fusulinae, one-celled marine animals of the foraminifer group, characteristic of the CARBONIFEROUS PERIOD in geological history. The shells resemble rice grains in size and appearance. They are of geological importance as marking the time when extensive COAL deposition began.

FUTRALL, JOHN CLINTON (1873-), American educator, was born at Jackson, Tenn., Mar. 9, 1873. He studied at the University of Virginia, at Johns Hopkins, and at Bonn and Halle, Germany. In 1894 he became associated with the University of Arkansas where he served as professor of Latin and Greek until 1913, was acting president in 1913-14, and became president in Mar. 1914. Futrall has contributed frequently to educational journals.

FYZABAD, the name of a city, district and division in the United Provinces, British India. The city, situated on the river Gogra and served by the East Indian railroad, is a station for British and Indian troops. Cotton weaving is the chief industry. The district of Fyzabad, situated between the Gogra and Gumti rivers, produces much cotton. Area 17 sq. mi. The division of Fyzabad includes the districts of Fyazbad, Bara Banki, Partabgarh, Bahraich, Sultampur and Gonda. Area 12,101 sq. mi. Pop. 1921, city, 56,620; district, 18,058; division, 6,599,401.

G

GABBRO, a coarse to fine-grained group of IGNEOUS Rocks, dark in color, composed largely of the PLAGIOCLASE feldspars labradorite or anorthite, and the PYROXENES diallage or augite, with OLIVINE. BIOTITE and HORNBLende may be present. If the pyroxene is enstatite or hypersthene, the rock is called NORITE. Anorthosite consists almost entirely of LABRADORITE. Diabase is a gabbro of particular structure. The BASALTS are the very fine-grained equivalents of the gabbros.

Gabbro is used somewhat in road-building and in monumental work. Anorthosite is employed as an ornamental stone. Gabbros are common rocks, widely distributed. *See also* DOLERITE; PERIDOTITE; PETROLOGY; TRAP ROCK.

GABELLE, a tax of the French monarchy on the consumption of salt. Since each individual was required by law to purchase regularly a certain amount of salt at a fixed price, it amounted practically to a direct tax. It was first imposed in the 13th Century and was abolished in 1790.

GABLONZ (Czech *Jablonec nad Nisou*), a Czechoslovak city in northern Bohemia noted for its glass industry. Thousands of workers in Gablonz and nearby make glass pearls, glass buttons, imitation precious stones, lighting fixtures and stained glass. These products are shipped to all parts of the world. There are also textile and machine factories, together with other minor industries. The inhabitants are mostly Germans. Pop. 1930, 33,855.

GABRIEL (Hebrew for *Man of God*), one of the four great archangels mentioned in the Book of Enoch, and the angel who appeared before the Biblical characters, Daniel, Zacharias and the Virgin Mary. In the Koran Gabriel serves as the agency for divine revelation. He occupies an important place in Mohammedan theology as well as in the hagiology of the Eastern Christian churches.

GABRIEL DE MÉZIÈRES, ANGE-JACQUES (1698-1782), French architect, was born at Paris, Oct. 23, 1698. He studied under his father, a court architect and friend and disciple of JULES HARDOUIN MANSARD, and in 1728 was admitted to the Academy of Architecture. Until his father's death in 1742 he worked jointly with him, and then rose to prominence in completing the unfinished portions of his work. He built the École Militaire at Paris, the Salle de l'Opéra at Versailles and in 1749 was commissioned to build the Hermitage at Fontainebleau and the Petit Trianon at Versailles. The last, like much of Gabriel's work, was personally directed by Mme. de Pompadour, mistress of Louis XV, but she died before it was completed and it became the palace of Countess du Barry, her successor in the king's favor. Much of Gabriel's later work was influenced by the

taste of du Barry as his earlier work had been by that of Pompadour, which in part must account for the femininity which Gabriel put into French Rococo at the same time that, because of his own strict classical training, he prevented it developing into the extravagances of the German. He died at Paris, Jan. 4, 1782.

GABRIELINO, an American Indian dialectic and tribal group of the Shoshonean linguistic stock which occupied practically all of Los Angeles Co., Calif., south of the San Bernardino mountains. Catalina and possibly San Nicolas islands were also Gabrielino territory. They are now extinct. Like most southern Californians, they were followers of the Jimson weed cult, practiced shamanism, lived in tule houses, made baskets and vessels of steatite and plank canoes. Little is known of their social customs.

GABRILÓWITSCH, OSSIP SALAMONOWITCH (1878-), Russian pianist and conductor, was born at Petrograd, Feb. 7, 1878. He won the Rubinstein Prize at the Petrograd Conservatoire, where he studied composition with GLAZOUNOV. During 1894-96 he studied with LESCHETIZKY at Vienna. His début at Berlin in 1896 was followed by successful European tours, in which he gave his series of six historical concerts, illustrating the development of the piano concerto from BACH to RACHMANINOFF. During 1910-14 he conducted the symphony orchestra at Munich, and in 1918 was appointed Conductor of the Detroit Symphony Orchestra, since appearing at intervals at piano recitals.

GABROVO, a town of Bulgaria, situated on the Yantra River, 20 mi. southwest of TIRNOVO, and 15 mi. north of the Shipka Pass, made famous in the Russo-Turkish War of 1877-78. Gabrovo, with its textile mills, is often called the Bulgarian Manchester. Tanning and pottery making are also important industries. The Bulgarian people looked upon the town as the center of the national rebirth, since it was here that the first Bulgarian school was founded. Pop. 1931, 10,613.

GAD, in Biblical account, a prophet or seer and intimate of David, represented in I Chronicles 29:29 as having composed a chronicle or history of David's exploits. Gad the prophet should be distinguished from the Gad mentioned in Genesis as son of Jacob and as the name of a tribe of Israel.

GADE, NIELS VILHELM (1817-90), Danish music composer, was born at Copenhagen, Feb. 22, 1817. He was a violinist in the Royal Copenhagen Orchestra, and with his *Ossian* overture won the Copenhagen Musical Union prize. A stipend from the king enabled him to study at Leipzig, where he was befriended by MENDELSSOHN, who appointed him assistant conductor during the 1845-6 season of the

gewandhaus concerts. He became Hof-Kapellmeister at Copenhagen in 1861. His works reflect his interest in Scandinavian folk-song. He died at Copenhagen, Dec. 21, 1890.

GAD-FLY, a popular name for about 1,500 species of swift-winged flies (*Tabanidae*) distributed throughout the world. The larvæ are predacious on slugs, snails, worms and other insects in water, moist earth and decaying wood. Adult males live on flower nectar. Females can also do this but usually prefer the blood of mammals and man. The mourning horse-fly (*Tabanus atratus*) is particularly annoying to horses during hot weather.

GADOLINIUM, a metallic chemical element belonging to the rare earths, discovered by Marignac in 1886, occurring in the minerals monazite and gadolinite. Its chemical symbol is Gd, atomic weight 157.3; its salts are colorless.

GADSDEN, CHRISTOPHER (1724-1805), American patriot, was born at Charleston, S.C., Feb. 16, 1724. After receiving a classical education in England he returned to America and became a prosperous merchant in Charleston. In 1757 he entered the provincial assembly, serving as a member for many years. He was a delegate to the Colonial Congress which met at New York in 1765 to denounce the STAMP ACT. As a member of the First Continental Congress in Philadelphia, 1774-76, Gadsden consistently advocated firm opposition to the British Parliament. Upon the outbreak of the war he entered the revolutionary army as colonel and rose to the rank of brigadier-general. He participated in the defence of Charleston in 1776, and helped frame the state constitution in 1778. As lieutenant-governor of South Carolina he signed the capitulation of Charleston in 1780, following which he was imprisoned by the British for almost a year. The Assembly of his native state chose him as governor in 1782, but he declined the office alleging age and ill health. Gadsden was a delegate to the South Carolina convention of 1788 which ratified the United States Constitution, and to that of 1790 which adopted the new state constitution. He died at Charleston, Aug. 28, 1805.

GADSDEN, JAMES (1788-1858), American soldier and diplomat, was born in Charleston, S.C., May 15, 1788. He served in the War of 1812 and against the Seminole Indians. In 1853 President Pierce appointed him Minister to Mexico, and in that year he concluded the Gadsden Treaty which adjusted the boundary and sold a small western area to the United States. He died in Charleston, S.C., Dec. 25, 1858.

GADSDEN, a progressive industrial city of Alabama and county seat of Etowah Co., on the Coosa River, about 65 mi. northeast of Birmingham. Several railroads, including the Louisville and Nashville and the Southern, serve Gadsden, the trading center of a cotton, grain, iron, coal and timber district. The Coosa River furnishes hydroelectric power. An important steel works produces material for a large percentage of the wire in the United States. Gadsden

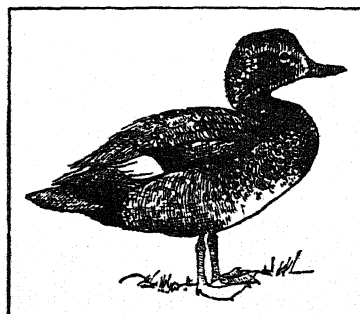
also has factories making furnaces, cast iron pipe, automobile tires, furniture, cotton and silk products. In 1929 the value of the manufactures was about \$12,000,000; the retail trade amounted to \$12,900,930. A state school of trades is located in Gadsden. Founded about 1845, Gadsden was chartered in 1871. Pop. 1920, 14,737; 1930, 24,042.

GADSDEN PURCHASE, a tract of land, about 20,000,000 acres, along the southwestern border of the United States, purchased from Mexico for \$10,000,000 in 1854. James Gadsden, United States minister to Mexico, negotiated the sale with Santa Anna, president of Mexico. The intention was to acquire sufficient land south of the rugged Gila Valley to provide an easily graded roadway for the projected (Southern) Pacific Railroad.

GAD'S HILL PLACE, the home of the novelist CHARLES DICKENS from 1857 till his death in 1870; situated on Gravesend Road, near Rochester, Kent, England. Various relics of Dickens are preserved at the nearby local museum, Eastgate House, which has been identified with the "Westgate House" of PICKWICK PAPERS and also with the "Nun's House" in *Edwin Drood*. Close by are the Cooling Marshes, scene of the opening incidents in *Great Expectations*.

GADSKI, JOHANNA (1873-1932), dramatic soprano, was born at Anklam, Prussia, June 15, 1873. She made her operatic début at Berlin, singing in *Der Freischütz*, later appearing in many German cities. She came to the United States in 1894 as a member of the Damrosch Opera Company, and sang chiefly Wagnerian rôles. In 1899 she appeared at Bayreuth. During 1898-1904 and 1907-17 she appeared at the Metropolitan Opera, New York, where her Brunnhilde and Isolde were noteworthy performances. In 1923 she became associated with German opera companies in the United States and later returned to Germany, where she died Feb. 23, 1932.

GADWALL (*Chaulelasmus streperus*), a fresh water dabbling duck closely allied to but smaller than the mallard, highly esteemed for game and also



G. M. SUTTON. "BIRDS OF PENNSYLVANIA."
J. HORACE MCFARLAND CO. COPYRIGHT

GADWALL, MALE

called gray duck. It is widespread in all subarctic regions and ranges more or less throughout North America, though rather uncommon in the east. The male is about 20 in. long, with generally brownish gray plumage blacker on the neck and breast, and

marked with white and chestnut on the wings; the female is somewhat smaller and lighter. The gadwall is a strong, rapid flyer and feeds chiefly in shallow water upon seeds, grain and aquatic insects. It builds a nest on the ground near the water, laying 8 to 12 pale buff eggs.

GAEA, GAIA or GE, in Greek mythology, the earth goddess, the same as the Roman Terra or Tellus. She was the daughter of Chaos, and the mother of URANUS and Pontus, also of the TITANS and CYCLOPS.

GAETA, a seaport of Italy, situated on the Gulf of Gaeta, 40 mi. northwest of Naples. The town has an excellent harbor which is used as a naval station. Gaeta is the center of considerable trade, but interest in it is due chiefly to its historical associations. In ancient times it was a pleasure resort for wealthy Roman families, and was called Portus Caietae. It was an important and prosperous commercial center. In the Middle Ages the town was seized by the Arabs, from whom it was redeemed by Pope Leo IV. In the 18th century it was successively taken by Austrians, French and Spaniards. The armies of United Italy defeated Francis II of Naples at Gaeta in 1860. Pop. 1931, 22,882.

GAFFNEY, a city and the county seat of Cherokee Co., in northwestern South Carolina, situated 5 mi. from the Broad River and 20 mi. northeast of Spartanburg. Bus lines, truck lines and the Southern Railroad serve the city. Cotton, grain and potatoes are the chief crops of the region. The district possesses various natural resources, including gold, tin and iron. Cotton goods are the principal manufacture. Sylca Springs, noted for their iodine contents, are just outside the city. During the Revolution the BATTLE OF KINGS MOUNTAIN in 1780, and the BATTLE OF COWPENS in 1781 were fought in the vicinity. Gaffney was founded and incorporated in 1872. Pop. 1920, 5,065; 1930, 6,827.

GAGE, LYMAN JUDSON (1836-1927), American financier, was born June 28, 1836, at De Ruyter, N.Y. Starting as clerk in the Merchants' Loan & Trust Company, Chicago, he later became president of the First National Bank, Chicago. In 1892 Gage became nationally known as the president of the board of directors of the World's Columbian Exposition. In 1897 McKinley appointed him Secretary of the Treasury, which office he held until January, 1902, when he resigned, becoming president of the United States Trust Company, New York City. He retired in 1906 and died at San Diego, Calif., Jan. 26, 1927.

GAGE, THOMAS (1721-87), British general and military governor of Massachusetts, was born at Firle, Sussex, in 1721, and became a lieutenant in the English army at 20. Seeing wide service in America, in 1763 he rose to supreme command of the British forces in the colonies. The story runs that, after receiving a deputation of Boston children who protested against the soldiers invading their playgrounds and destroying their snow forts, Gage ordered his men to desist. In 1775 the BATTLE OF LEXINGTON

was fought after he had sent troops to seize war material at Concord. When Gage nearly lost the BATTLE OF BUNKER HILL, he was recalled to England. He died in 1787.

GAGER, CHARLES STUART (1872-), American botanist, born in Norwich, N.Y., Dec. 23, 1872. He was graduated with an A.B. degree from Syracuse University in 1895 and continued his scholastic work at N.Y. State Normal College, where he took his Pd.B. and Pd.M. degrees, 1896 and 1897; he received his Ph.D. degree at Cornell in 1902. During his long educational career, he was a physiography and biology professor at N.Y. State Normal College, 1897-1905, the head of the N.Y. Botanic Garden laboratory, 1906-08, a botany professor at the University of Missouri, 1908-10, and director of the Brooklyn Botanic Garden. He became editor of the *Brooklyn Garden Record*, in 1912, business manager of the *American Journal of Botany* in 1914, of *Ecology* in 1920 and of *Genetics* in 1922. He is the author of *Errors in Science Teaching*, 1901; *Effects of the Rays of Radium on Plants*, 1908; *Fundamentals of Botany*, 1916; *Heredity and Evolution in Plants*, 1920; the *Relation Between Science and Theology*, 1925; and *General Botany, with Special Reference to its Economical Aspects*, 1926.

GAIA. See GAEA.

GAILLARD, DAVIS DUBOSE (1859-1913), American army engineer, born in 1859. He was a graduate of the United States Military Academy, a member of the International Boundary Commission of the United States and Mexico, was engineer in charge of the Washington Aqueduct, 1895-98 and distinguished himself in the Spanish-American War. Since 1907 a member of the Isthmian Canal Commission and director of the Panama Railroad Company, Gaillard was made in 1908 engineer of the central division of the canal from Gatun to Pedro Miguel. He died in 1913.

GAILLARDIA, a genus of handsome annual or perennial herbs of the composite family. There are about 12 species native chiefly to the western United States, several of which are commonly planted as garden ornamentals. The hairy branching stems bear narrow toothed leaves and numerous large, often fragrant, long-stalked flower-heads, composed of showy yellow or yellow and red rays surrounding a purple center.



P. A. RYDBERG. "FLORA OF PRAIRIES AND PLAINS"

GAINES, FRANCIS PENDLETON (1892-),

American educator, was born at Due West, S.C., Apr. 21, 1892. He studied at Richmond College, the University of Chicago and Columbia. From 1914-23 he was successively instructor, associate professor and pro-

GAILLARDIA
Gaillardia pulchella

fessor of English at the Mississippi Agricultural and Mechanical College. For the next three years he was professor of English at Furman University. Gaines was literary editor of the Greenville *Piedmont* in 1925-6; and in 1927 became president of Wake Forest College. In 1930 he became president of Washington and Lee University. Gaines wrote *The Southern Plantation*, 1924.

GAINESVILLE, a city in northern Florida, situated near the center of the peninsula, 70 mi. southwest of Jacksonville, on Newman Lake. Gainesville is the county seat of Alachua Co. It is served by three railroads and by bus and truck lines. Truck crops, fruit, tobacco and tung trees are raised in the vicinity. There are also phosphate mines nearby. The tung trees were imported from China, and their cultivation has been successful and profitable. The retail trade in 1929 reached a total of \$5,792,055. Gainesville is a winter resort and an education center. It is the seat of the University of Florida and also of the Florida Agricultural Experiment Station. The country around Gainesville is unusually beautiful and interesting. There are in the vicinity 90 clear-water lakes and numerous mineral springs and wells. Alachua Sink and the Devil's Millhopper are the meccas of many nature lovers. Gainesville was founded in 1756. It was incorporated in 1907. Pop. 1920, 6,860; 1930, 10,465.

GAINESVILLE, a city and county seat of Hall Co., in northeastern Georgia, situated 48 mi. northeast of Atlanta; it is served by three railroads. Gainesville is primarily a textile city, although there are factories manufacturing chairs, wagons and overalls. The Riverside Military Academy and Brenau College for Women are situated here. The nearby mineral springs make the city a popular resort. Pop. 1920, 6,272; 1930, 8,624.

GAINESVILLE, a city in northern Texas, the county seat of Cooke Co. It is situated near the Red River, 65 mi. northwest of Dallas and is served by two railroads. The city is surrounded by a rich agricultural region; cotton, grain and live stock are the leading products. Oil fields lie in the vicinity, and, with an oil refinery and garment factory, the city is a busy shipping center. It is the seat of a junior college and the state training school for girls. Gainesville was founded in 1851 and incorporated as a city in 1879. It was named in honor of Edmund P. Gaines, an officer in the Mexican War. Pop. 1920, 8,648; 1930, 8,915.

GAINSBOROUGH, THOMAS (1727-88) English portrait and landscape painter, was born at Sudbury, Suffolk, in 1727. He learned more from a study of Van Dyck than from the negligible artists of the day, and after 3 years' apprenticeship in London, settled at Ipswich, where he began those admirable landscape studies in the Dutch manner which have only recently received recognition. In 1759 Gainsborough removed to Bath and thence to London, where he quickly became the vogue in both literary and court circles. Among his sitters were

Sheridan, Burke, Lady Mary Montagu, Mrs. Siddons, Dr. Johnson, Clive, Franklin and Blackstone. The characteristics of Gainsborough's 220 portraits are grace, spirit and spontaneity. The most famous of them are *Elizabeth, Duchess of Devonshire*, which was stolen in 1876 and recovered in 1901, and the *Blue Boy*. The latter is now in the collection of Henry E. Huntington at Pasadena, Cal., having been purchased in 1921 from Sir Joseph Duveen for the sum of \$640,000. Gainsborough died at London, Aug. 2, 1788.

GAINSBOROUGH, an old market town and port in the county of Lincoln, eastern England; on the river Trent. Lincoln lies 16 mi. to the southeast. It is a significant railroad junction. The making of Gainsborough into a port in 1841, and the construction of canals joining it with the River Trent gave the town an important commercial advantage. It became the eastern market for the Midland region. Malt, ropes, linseed oil, tobacco and machinery are among the chief manufactures; iron works and ship-building yards afford further occupation. Gainsborough's most celebrated structure is the Old Moot Hall, dating from the 15th century. Pop. 1931, 18,684.

GAIRDNER, JAMES (1828-1912), English historian, was born at Edinburgh, Mar. 22, 1828. After completing his studies, he went to London in 1846, and found employment in the Public Record Office. He was promoted to assistant keeper of the records in 1859 and retained the post until 1893. His work in editing various historical papers, notably of the reigns of Richard III, Henry VII and Henry VIII, fitted him for writing the histories and monographs by which he is best known. These include: *The Houses of Lancaster and York*, *Richard III*, *Henry VII*, and *The English Church in the 16th Century*. His *Lollardy and the Reformation in England* was completed by G. H. Hunt. Gairdner's scholarly edition of *The Pastor Letters* was first published in 1875. He died at Pinner, in Middlesex, on Nov. 4, 1912.

GAISERIC (c. 400-477), King of the VANDALS, made that hitherto comparatively weak tribe the scourge of the Mediterranean. Becoming sole king on the death of his brother Guntheric about 428, he led the whole tribe from Spain into Africa. A civil war there facilitated his conquests. Acknowledged as a tributary ally by Valentinian III in 435, he treacherously seized Carthage four years later. With that harbor as a base, his fleets harried the Mediterranean coasts. In 455, at the invitation of Eudoxia, widow of the murdered Valentinian, he descended on Rome and for two weeks pillaged the unresisting city. Eudoxia and her two daughters, one of whom married his son Hunneric, were brought captive to Carthage. A fleet sent against him by the Emperor Marjorian in 460 was destroyed. Eight years later he defeated a formidable force sent to Africa by both emperors. The large estates of the African provincials were made royal domains; other estates were allotted to his warriors, the poorer lands being left to the provincials, who had to bear the burden of taxation. Catholic

churches were devoted to Arian worship or destroyed, and their bishops exiled, but there was little official persecution of laymen. Gaiseric died on Jan. 25, 477.

W. I. B.

GAIUS CAESAR. See CALIGULA.

GALACTOSE, an organic chemical compound belonging to the CARBOHYDRATES and a monosaccharose of the formula $C_6H_{12}O_6$. Together with GLUCOSE it is formed by the inversion of LACTOSE, and resembles FRUCTOSE in its properties, though it is a feeble reducing agent, and not so sweet in taste.

GALAGO, the "palm-rat" or "bush baby" of African forests. These large-eyed, long-tailed, woolly



GALAGO

From the Belgian Congo,
Africa

gray lemur, the size of a squirrel, are chiefly active at night when they execute amazing leaps among the trees. Owing to the shortness of the fore limbs, their ground gait is a kangaroo-like hop. They have peculiar naked, folding ears. They devour insects, birds' eggs, and fruits.

GALAHAD or **SIR GALAHAD**, in the ARTHURIAN LEGENDS, is the perfect knight. He is the son of Elaine, daughter of King Pelles, and Lancelot, himself one of the greatest

knights at King Arthur's Round Table. It is Galahad who sits in the "Siege Perilous" at the Round Table, draws the immovable sword from the rock and at last as he is dying achieves his life's aim of receiving the Holy Grail.

GALAPAGOS ISLANDS, a small volcanic archipelago, mostly uninhabited, lying 600 mi. off the coast of Ecuador, to which they belong. They occupy a sea-area about 130 mi. in diameter. Twelve are of considerable size, the largest being Albemarle.

Scientific interest was directed to Galapagos wildlife by the visit of CHARLES DARWIN in 1835, on account of the numerous species of birds, reptiles, insects and plants elsewhere unknown, or even peculiar to individual islands of the group. The archipelago takes its name, which is Spanish for turtles, from gigantic land-tortoises which formerly bred there in immense numbers, each of the larger islands having species of its own. Large specimens measured 5 ft. in length and weighed 500 lbs.

Early navigators found these giant turtles dainty eating, and for 300 years merchantmen and whalers loaded their decks with living "turpin," or "Galapagos mutton," with the result that the tortoises are now extinct on 10 of the 12 islands they once inhabited, surviving only in the mountainous interior of Albemarle and Indefatigable. The Galapagos fur-seals were long ago exterminated. Flightless cormorants, flamingoes, and the great land-iguanas are now scarce. An effort is being made under the auspices

of the New York Zoological Society to save the Galapagos turtles from extinction by planting colonies in southern Florida.

GALASHIELS, a municipal burgh of Selkirkshire, Scotland, lying on Gala Water just before it joins the Tweed, about 33 mi. southeast of Edinburgh. At first built to house those who came on pilgrimages to nearby Melrose Abbey, to-day it is a busy manufacturing town with mills and factories following both river banks, and with the residential quarters above. Galashiels has factories for making leather, hosiery and tweeds. Pop. 1921, 12,946; 1931, 13,102.

GALATEA, in Greek mythology, a sea nymph or Nereid, daughter of NEREUS and Doris. She was beloved by a Sicilian shepherd, Acis, son of Faunus and Symethis. The Cyclop POLYPHEMUS was jealous of Acis and rolled a rock from Aetna on his head and killed him. At Galatea's plea NEPTUNE turned Acis into a stream. One legend says that Galatea was mother of Galas by Polyphemus.

GALATIANS, EPISTLE TO THE, in the New Testament, is a letter generally believed to have been written by the Apostle Paul to the churches in Galatia, probably about 56 A.D., or earlier. Just which churches were addressed is debatable; but it is commonly assumed that they were composed not only of Galatians, but of Greeks, Phrygians, Romans and Jews. In a style more rugged than his other writings, Paul states his doctrine of justification by faith more emphatically than elsewhere, and stresses his apostolic authority. The Apostle's rebuke of the fickle temperament of the Galatians curiously confirms Caesar's description of the same people. In this epistle are the familiar passages, "I have been crucified with Christ, yet I live," and "Far be from me to glory, save in the cross of our Lord Jesus Christ." Here Paul earnestly insists that the fruits of the spirit are love, joy, peace, long-suffering, faithfulness, meekness and temperance, "against which there is no law."

GALATZ, capital of the department of Covurlui in Rumania, situated on the left bank of the Danube. This city is Rumania's largest port on the Danube and its importance is increased by the fact that it lies so close to the junction of the Danube with the Galatz and Pruth. Much merchandise is transhipped there to small draught steamers. Galatz handles more imports than any other port in Rumania and facilitates the exportation of the products of local manufacture such as petroleum by-products, flour, chemicals, light metals and matched woods. It is also an important grain shipping point. Galatz is the see of a bishop, the permanent station of an army corps, and the headquarters of the international commission for the control of Danubian traffic. Pop. 1930, 101,148.

GALAX (*Galax aphylla*), a smooth, stemless, evergreen perennial of the diapensia family common in open woods from Virginia to Georgia. The creeping, scaly rootstocks give rise to bright-green, round heart-shaped leaves and slender flower-stalks bearing spikelike clusters of small white blossoms. The shining, handsome leaves are gathered in large quantities

for the use of florists in making corsages and other decorative bouquets.

GALAXY, that great stellar system to which the sun belongs. See **MILKY WAY**.

GALE, ZONA (1874-), American novelist, was born in Portage, Wis., Aug. 26, 1874. She was graduated from the University of Wisconsin in 1895 and received her Master of Arts degree four years later. In 1918 she published her first novel, *Birth*, but not until *Miss Lulu Bett* appeared in 1920 did she achieve fame from her work. *Faint Perfume*, published in 1923, is among her best novels. *Preface to Life, Portage Wisconsin and Other Essays*, and *Borgia* has sustained her reputation. In 1920 Zona Gale dramatized *Miss Lulu Bett* and was awarded the Pulitzer Prize for this play.

GALE, in botany, the common name given, especially in Great Britain, to the **SWEET GALE** (*Myrica Gale*), a small shrub with fragrant leaves, found in northern bogs.

GALE, a wind of great strength, indicated by the numbers 8 or 9 on the Beaufort scale of wind strength, and, as measured by the anemometer, having a velocity of from 40 to 50 miles per hour. It is inferior in speed and strength to a storm and lacks a storm's power to do damage other than to small objects.

GALEN (131-201 A.D.), Greek physician and founder of experimental physiology, was born in Pergamum, capital of Mysia in Asia Minor. He began the study of medicine in 146. He traveled through Greece, Cilicia, Phoenicia, Palestine and Alexandria in search of knowledge, and he located in Rome in 164. Galen attacked by his pen the medical sects then quite popular in Rome—and thereby aroused the hostility of his profession. He belonged to no particular school, but in philosophy followed Aristotle. Little is known of the later years of his life. He died in A.D. 201, probably in Sicily. Galen wrote about five hundred treatises in Greek. Next to Hippocrates, Galen was the most distinguished physician of his time. His anatomical investigations were exceedingly accurate. His works and conceptions dominated medicine for eight hundred years after his death. M. F.

GALENA, an important **ORE** of lead, heavy, soft, and lead-gray in color. It is found in veins and in pockets and channels in limestone; it is often associated with sphalerite, pyrite and marcasite, and frequently contains silver. Galena is lead sulphide, crystallizing in the **ISOMETRIC SYSTEM**. It occurs in both solid and granular masses, and frequently in rectangular crystals. It resists **WEATHERING**, so is often found "at the grass roots." Galena is mined in Missouri, Idaho, Colorado, Wisconsin, and in Europe in Belgium, Prussia and Sardinia. The name is derived from the Latin for lead ore. See also **ORE DEPOSITS**.

GALENA, a town in the northwestern corner of Illinois, the county seat of Jo Daviess Co. It is situated on the Galena River, near the Mississippi, 14 mi. southeast of Dubuque, Iowa. River craft and three

railroads serve the town. Galena has factories making heating furnaces, registers, axle grease, handles, machinery and gloves, and there are iron, zinc and lead works. Sulphide of lead was discovered here about 1820. Galena was incorporated in 1835. **ULYSSES S. GRANT** lived here for several years prior to the Civil War. Pop. 1920, 4,742; 1930, 3,878.

GALESBURG, a city of middle western Illinois and county seat of Knox Co., about 55 mi. from Peoria. It is on the Burlington and the Santa Fé railroads, and has extensive shops of the Burlington route. The city is located in a productive grain and coal region, and is supplied with water from three artificial lakes near by. It has numerous and diversified manufactures, including brick-discs, farm gates, and boilers, and specializes in livestock, being a notable horse and mule market. In 1929 the value of the factory output was about \$16,000,000; the retail trade amounted to \$18,822,405. A Presbyterian minister from New York state, Rev. G. W. Gale, for whom the town was named, chose the site for a theological seminary and settlement of "free-soilers," in an attempt to stem pro-slavery tendencies in Illinois. A colony of followers bought the land, and **KNOX COLLEGE** was chartered in 1837. The city's charter dates from 1857. Pop. 1920, 23,834; 1930, 28,830.

GALICIA, the southern portion of Poland. It lies north of the Carpathian Mountains, extending from the Czecho-Slovakian border to Roumania and the Union of Socialist Soviet Republics. Until 1918 Galicia was the largest province of Austria. West Galicia was definitely assigned to Poland after the World War; East Galicia existed as an independent state under Polish protection until 1923 when it was recognized to be an integral part of Poland.

GALICIAN or **GALLEGO**, a **ROMANCE** dialect spoken by about 1,000,000 people in Galicia (North-western Spain). It is essentially a **PORTUGUESE** dialect more or less influenced by **SPANISH**, the main differences from the former being in vocabulary and in the loss of much of the nasalization characteristic of Portuguese, e.g., Latin *manu*="Galician *man* or *mao* as contrasted with Portuguese *mão*, "hand."

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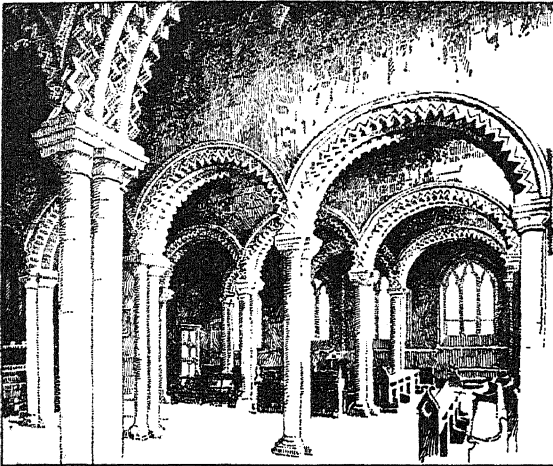
GALILEE, in English medieval architecture, an enclosed porch or narthex of a church. Although strictly the term may be used of any enclosed church porch, it is now usually used only to express the rich projecting side porches common in English Gothic churches. Frequently these structures are of two or more stories, with rooms above the porch, used as chapels, meeting rooms, or for the sacristan. Beautiful examples exist at Southwell, 12th century; Salisbury, 13th century, and Lavenham, Woolpit and Lynn, all of the 15th century.

See Francis Bond, *An Introduction to English Church Architecture*, 1913, pp. 718-734.

GALILEE, SEA OF, a lake in Palestine, through which flows the River Jordan. Situated 680 ft. below sea level, the lake is 6 mi. broad, 14 mi. long and has

a maximum depth of 150 ft. It is often mentioned in the Bible and the sites in the vicinity of the lake have great archeological interest.

GALILEO GALILEI (1564-1642), Italian astronomer and physicist, was born at Pisa, Feb. 18, 1564.



DURHAM CATHEDRAL: THE GALILEE

As a boy he displayed marked aptitude for mechanics, and later proved himself to be an astute observer, possessing remarkably keen reasoning powers. In 1581 he was sent to the University of Pisa where he studied medicine, but soon turned to mathematics and physics. From 1589 to 1591 he was on the faculty at Pisa, from 1592 to 1610 professor at Padua. Often called the father of experimental science, he derived the laws of the motion of a pendulum at the age of 18, after observing the swinging of the bronze lamps in the Pisa cathedral. His experiments in dropping bodies of different sizes and weights from the leaning tower in Pisa demonstrated the fact that all objects fall with equal speed, but it procured him the enmity of his Aristotelian colleagues. He invented the thermometer and, upon hearing rumors of a telescope having been invented in Holland, constructed one for himself in 1609. With this he discovered the satellites of Jupiter, the phases of Venus, the sun spots, the mountainous surface of the moon, and the faint stars in the Milky Way. He openly professed his belief in the Copernican theory of the universe, which he defended, while ridiculing the opposite point of view, in his famous *Dialogue of the two Chief Systems*, 1632. In so doing he offended the previously friendly ecclesiastical powers, who now summoned him before the inquisition and made him publicly abjure his beliefs on June 22, 1633. He was sentenced to imprisonment, but almost immediately allowed to live in his villa in Florence. By 1637 he had become blind, and was allowed more freedom, and permitted to have visitors, among whom was MILTON. He died at Florence, Jan. 8, 1642.

GALINGALE, in botany, the common name applied to many species of *Cyperus*, a large genus of

rushlike or reedlike plant of the sedge family. See *CYPERUS*.

GALION, a city in northern Ohio, in Crawford Co., situated 80 mi. southwest of Cleveland and served by two railroads. It is surrounded by grain fields and has many manufactures, including overcoats, machinery and metal products. The city was established in 1831. Pop. 1920, 7,374; 1930, 7,674.

GALISE CREEK, or Taltushtundude, an American Indian tribe speaking a dialect of the Athapaskan stock and living formerly on Galice Creek in Oregon, in the same territory as the Takelma. They are now extinct as a tribe.

GALL, FRANZ JOSEPH (1758-1828), founder of phrenology, was born at Tiefenbrunn near Pforzheim, Baden, March 9, 1758. He studied at Baden, Strasbourg and Vienna, practicing medicine in the latter city. Gall was convinced that special abilities and the disposition of man were governed by the functions of the brain, and that these facts could be determined from the external appearances of the skull. Thus he is the founder of the pseudo-science of "phrenology." In 1791 he published a book entitled, *Philosophical-Medical Researches Concerning Nature and Science in Disease and Health*. He died in Paris on August 22, 1828. M.F.

GALLAND, ANTOINE (1646-1715), French orientalist and numismatist, was born at Rollot, Department of Somme, Apr. 4, 1646. After studying oriental languages of the Collège de France, he traveled in the East. In 1701 he was admitted into the Academy of Inscriptions, and later became Professor of Arabic in the Collège de France. His writings relate mainly to numismatics, but his lasting fame was secured as the first European translator of the *ARABIAN NIGHTS*. Galland died Feb. 17, 1715, in Paris.

GALLATIN, ALBERT (1761-1849), American statesman and author, was born at Geneva, Switzerland, Jan. 29, 1761. Of aristocratic lineage, he was splendidly educated, formally at the Academy of Geneva and informally by association with the refined and enlightened society of his native town. His radical ideas he felt incompatible with a residence in Geneva, so he emigrated to the United States in 1780. He taught French at Harvard in 1782 and in 1784 he crossed the Alleghenies to settle in Fayette Co., Pa., where he had purchased a huge tract of land. His alert mind and excellent education quickly made him a prominent figure in western Pennsylvania. As a member of the State Legislature from 1790 to 1793 he demonstrated his mastery of financial legislation. Despite his affiliation with the Democratic-Republicans, the Federalist State Legislature in 1793 complimented him by electing him to the United States Senate. He attempted to take his seat but the Senate, strongly Federalist, by a vote of 14-12 deprived him of it on the ground that he had not been a citizen of the United States for nine years. From 1795 to 1801 he was a member of Congress, in which body he was of inestimable aid to the Democratic-Rep-

licans with his knowledge of constitutional and international law. Again he displayed an unusual understanding of the complex principles of financial affairs. President Jefferson appointed him Secretary of the Treasury in 1801, which office he held until 1813. Although his ideas of the proper financial policy of the nation were different from those of Hamilton, he is generally considered to have been equally brilliant in his administration of treasury affairs. His plan gradually to abolish the public debt, thereby reducing taxes, was not realized because of the foreign controversies and wars which involved the United States. As a member of the peace commissioners who negotiated the Treaty of Ghent in 1814 he distinguished himself for his equable temper and skilful handling not only of the British commissioners but of his quarreling American colleagues. He was Minister to France, 1816-23, and to Great Britain, 1826-27. His diplomatic services closed his public career. He settled in New York and at the request of John Jacob Astor accepted the presidency of the National Bank, later the Gallatin Bank, which he retained until 1839. His last years he devoted chiefly to ethnological studies. He wrote articles and in 1842 founded the American Ethnological Society. He died at Astoria, N. Y., Aug. 12, 1849.

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GALLAUDET, EDWARD MINER (1837-1917), American educator, was born at Hartford, Conn., Feb. 5, 1847. After graduation from Trinity College, Hartford, he taught in the school for deaf mutes, at Hartford, which his father, THOMAS HOPKINS GALLAUDET, had founded. In 1857 he founded in Washington the Columbia Institution for the Deaf and Dumb, developing it into the Gallaudet College for the deaf, and serving as its president, 1864-1911. His publications include *Popular Manual of International Law*, and *Life of Thomas Hopkins Gallaudet*. Gallaudet died Sept. 26, 1917.

GALLAUDET, THOMAS HOPKINS (1787-1851), American educator, was born in Philadelphia, Pa., Dec. 10, 1787. He was graduated from Yale in 1805, and then studied theology at Andover. Becoming interested in the education of the deaf and dumb he dropped his plans to preach and went to Europe to study methods used there in the deaf and dumb institutions. He then opened, in 1817, the first educational institution for deaf-mutes in the United States, at Hartford, Conn., and continued as its head for 13 years. Gallaudet was professor of education at New York University, 1832-33. His son EDWARD MINER GALLAUDET, carried on his work for deaf-mutes. He died at Hartford, Conn., Sept. 10, 1851.

GALL-BLADDER, a sac opening by the cystic duct into the duct (bile duct) which transports the bile from the liver to the lumen of the small intestine. The gall-bladder stores bile between meals and empties it by contraction when food is taken in, especially if it contain considerable fat, which it helps to digest.

GALL-BLADDER AND BILE PASSAGES, DISEASES OF. Inflammation of the lining of the

bile ducts—from within the liver to their exit at the intestine below the stomach—may obstruct the flow of bile and cause "catarrhal jaundice." (See JAUNDICE.) It follows many forms of general systemic infection, some of which may be mild but give rise to obstinate bile passage disease. Among these infective causes, may be tonsillitis, ear inflammations, measles, chicken-pox or more serious ailments as pneumonia, typhoid fever, etc. Inflammations arising in the lining of the stomach and bowels may progress up the gall ducts into the gall-bladder or the liver. Emotional disturbances at times may interfere with the emptying of the gall-bladder and bile ducts: the retained bile may produce inflammatory processes in the duct and gall-bladder linings and jaundice may follow. The patient may be but slightly ill, but in some instances, fever, liver region discomfort, loss of appetite, nausea and vomiting, together with jaundice, may incapacitate the patient for long periods. If infection becomes locally active in bile ducts or gall-bladder, abscess formation, with serious and even fatal consequences, may ensue. Gall-bladder inflammation (cholecystitis) may be sudden (acute), mild or severe. It is due chiefly to bacteria invading the wall or the lining of the gall-bladder. Often gall-stones accompany the inflammatory condition.

The infection by bacteria may arise from parts of the body far distant from the gall-bladder (tonsils, tooth abscesses, bowel disease, sore throat, sinus disease, etc.) or occur during the course of systemic ailments (la grippe, pneumonia, scarlet fever, etc.). Depending upon whether the infecting germ is slightly harmful or is very potent and upon the extent of germ invasion, the disease may be mild and of short duration or may be startlingly abrupt, serious or fatal. The consequences of the inflammation may range from but temporary loss of function of the gall-bladder to complete destruction of the organ, abscess formation and perforation (empyema of the gall-bladder).

The symptoms are abdominal pain (often "colicky"), nausea, vomiting, fever, tenderness below the liver and in severe instances, abdominal distention, prostration, persistent jaundice, weakened circulation and collapse. Mild forms of the ailment yield to rest, local abdominal heat, diet and medicines; severe and recurring instances require surgical intervention. Operative mortality in competent hands is less than 3 per cent.

Chronic gall-bladder inflammation (chronic cholecystitis) usually results from one or more prior attacks of mild inflammation which have subsided under treatment or spontaneously, and where surgery has not been sought or when performed has included only "drainage" of the gall-bladder.

As a consequence of inflammation, mild but progressive, the gall-bladder lining usually becomes partly or completely destroyed and the wall, scarred and thickened. The bile duct leading from the gall-bladder is usually affected similarly. If an acute inflammation occurs in a gall-bladder already affected with chronic inflammation, ulceration of the gall-

bladder lining or abscess formation in the wall may follow.

The gall-bladder bile becomes thick and viscid and loses its amber color. Chemical changes occur in the bile so that its reaction becomes acid instead of alkaline. When this takes place, "bile salts" are precipitated and lie in the gall-bladder as "gravel"-like particles; or by accretion, particularly when in contact with bacteria, mucus or dead lining cells, form larger particles, called "gall-stones." These vary in size from that of a pinhead to that of a chicken's egg. Their number may range from few to as many as thirteen or fourteen thousand. In consistency they may be like dry putty or as hard as a pebble, depending upon the relative proportions of bile pigment and lime in their make-up. Their color ranges from yellowish-amber to dull-greenish black or bronze. They may be round, ovoid, square as dice or of irregular contour. They may lie free in fluid or semi-solid bile or be imbedded in honeycomb like scar accumulations of the gall-bladder wall. At times, stones adhere, so that the entire gall-bladder is filled with a firm, putty- or rock-like mass. Bile and gall-stone accumulations may result in enormous enlargement of the gall-bladder: where, normally, its size is that of a chicken's egg, in disease, it may be as large as a child's head and its contents, if fluid, may be as several pints, with a like weight in pounds. Excessive stretching of the gall-bladder wall may result in its becoming paper-thin, in which circumstances it may burst spontaneously, or following a fall or jar, or when being handled during an operation.

Gall-stones may lie dormant in gall-bladders for years without causing discomfort. As a rule, however, their presence is accompanied by some grade of liver insufficiency and by digestive upsets, mild or severe, colloquially called "bilious attacks."

If gall-stones wander from the gall-bladder and pass through or lodge in the bile ducts, such migration usually is accompanied by severe pain, nausea, vomiting, fever, chills, jaundice and prostration. The symptoms persist until the stones pass freely into the small intestine or are surgically removed.

Gall-stones may form in any portion of the bile ducts, from the minute hair-like passages within the liver, down to the intestine. All needed for their formation is a slowly flowing bile, acid in reaction, which permits bile salts to be precipitated upon bits of mucus or about bacteria or dead gall-bladder or duct-lining cells. The rate of formation varies greatly: years may be required, or again, conditions being suitable, even large or numerous "stones" may form in a few weeks.

In certain individuals, gall-stone irritation to the lining of the gall-bladder or the bile ducts appears to be of a definite significance in the initiation of cancer. F. S.

GALLE, JOHANN GOTTFRIED (1812-1910), German astronomer, was born at Pabsthaus, June 9, 1812. In 1833 he became director of the Berlin Observatory. To him U. J. J. LEVERRIER sent his cal-

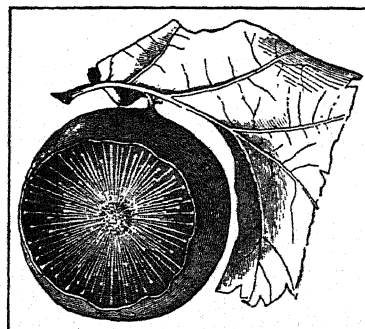
culations of the position of a trans-Uranus planet and on Sept. 23, 1846, he discovered Neptune. From 1851 to 1897 he was director of the Breslau Observatory, discovering three comets. In 1872, working from the transits of the inner planets, he improved the calculation of the solar parallax. He died at Potsdam, July 10, 1910.

GALLE or POINT DE GALLE, a seaport city of Ceylon situated on the southwest coast of the island. Its harbor has deep water, but is unsheltered. Since the development of the harbor of Colombo and the opening of the Suez Canal, Galle has declined as a seaport. Fiber, rope, rubber and coconut oil are among its exports. The Portuguese founded the city in 1518. Pop. 1931, 38,435.

GALLETA GRASS, a name applied in the western United States to three important range grasses (*Hilaria Jamesii*, *H. mutica* and *H. rigida*), found from Wyoming to Texas and westward to California. They are low perennials with erect stems, about 1 ft. high, with short narrow leaves and flowering spikelets appressed in terminal spikes. Closely allied to the galleta grasses, is the curly mesquite (*H. Belangeri*), a valuable grazing grass of the Texas uplands.

GALLEY, a term used nautically in three different ways. First, the place where cooking is done on a vessel, in other words the kitchen, which is usually located amidships. Second, a decked vessel propelled by oars as used during the Roman Empire. Third, in England, sailors often call a long narrow open boat using oars or sails a galley. In printing, the term refers to a flat, rectangular frame or tray for holding composed type.

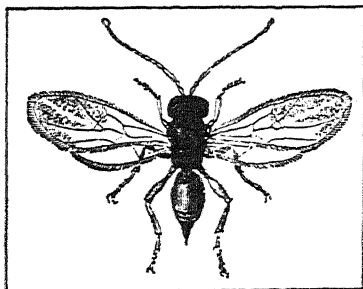
GALL-FLIES, minute wasp-like insects of the family *Cynipidae*, so named because of the peculiar swellings they produce on leaves, twigs, trunks and roots of living plants. Although called plant parasites by some entomologists, they do not eat infested tissue but form protective cells for themselves and by irrita-



OAK GALL PRODUCED BY A GALL-FLY
(*Cynips quercus-inana*)

tion cause the abnormal tissue swellings. In these the larvæ mature, subsisting upon the abnormal exudations of the plant. Each species makes its own characteristic gall. In some species both sexes appear in spring but in summer only "brood mothers" occur. The progeny of these may or may not resemble their

spring progenitors but their successors produce both males and females. In some species no males are known, so apparently the race is reproduced wholly by females! Roses, golden-rod, alder and many other



ROSE GALL-FLY
(*Rhodites rosa*)

common plants often show galls but the most varied assortment is on oaks.

GALLIC ACID (3,4,5 trihydroxybenzoic acid), occurs in small amounts in gall nuts and other vege-



ROSE GALL PRODUCED BY A GALL-FLY
(*Rhodites rosa*)

table materials containing **TANNIN**. Fermentation and hydrolysis with acids convert the tannin into more gallic acid, which crystallizes (silky needles) from cold water after boiling and filtering. Gallic acid is useful as an astringent, and in dyeing and photography. It does not react with gelatine, as does tannin.

GALLICANISM consists of the principles codified in, but not created by, the Declaration of the Clergy of France Concerning the Ecclesiastical Power, adopted in 1682. The origin of the principles has been traced by some students of religious history to the various privileges and liberties granted by the Papacy to the Catholic Church in France in the medieval ages. Gallicanism insisted that the Church had only spiritual jurisdiction, that ancient customs and regulations of the Church in France should be inviolate, and that the judgments of the Holy Father

are not irreversible until confirmed by the consent of the Church. This position restraining the papal power spread in the 18th century to the Low Countries and to Germany. The Synod of Pistoia in 1786 tried to introduce it beyond the mountains into Italy. Though still considered heretical, it has its advocates.

GALLI-CURCI, AMELITA (1889-), Italian singer, was born at Milan, Nov. 18, 1889. Intending to become a pianist, she entered Milan Conservatory, from which she graduated with honors in 1903. She renounced an instrumental for a vocal career and developed, entirely through her own efforts, a coloratura technic of great brilliance. In 1909 she made her operatic debut in Rome, later touring South America. She made her first appearance in the United States with the Chicago Opera Company in 1916. Her intonation was criticized by American critics, although the flexibility of her voice and its compass (A-F sharp in altissimo) were admitted to be phenomenal. During 1920-29 she sang with the Metropolitan Opera, New York.

GALLIENI, JOSEPH SIMON (1849-1916), French general, was born at Saint B  at, Haute Garonne, in 1849. He received military training at Saint Cyr, fought in the Franco-Prussian War in 1870, and the years following served with the French army on African explorations. He served also in Martinique, returning to Africa as governor of Upper Senegal, 1886-96, where he obtained many concessions from the Senegalese. He put down a revolt of Madagascar against the French in 1896 and became governor-general of Madagascar. Returning to France in 1905, he was prominent in the army until his retirement in 1914. At the opening of the World War in Aug., 1914, he was made military governor of Paris. It was through his cooperation with the army actively engaged and his rushing of reinforcements from civil sources in Paris that the advance of General Von Kluck was stopped at the Marne. In October, 1915, Gallieni was appointed Minister of War, but illness compelled him to retire in 1916, and he died on May 27 of that year at Versailles.

GALLINULE, a group (*Gallinulinae*) of medium-sized birds of the rail family found in most parts of the world. Like their close relatives the coots, they are usually dull-colored and have a horny shield on the front of the head, but, unlike the coots, their long, slender toes are without lobes. They frequent the borders of reedy and bushy marshes where they move about with remarkable swiftness and feed upon various aquatic plants and animals. When pressed they swim and dive well, but rarely take to wing. The Florida gallinule (*Gallinula chloropus cachinnans*), found widely in temperate and tropical America, is about the size of a small bantam, slate-colored above and somewhat lighter below, with the base of the bill and a conspicuous frontal plate bright red. It builds a rough nest, usually a few inches above the water, laying 8 to 13 buffy, brown-speckled eggs. Its noisy discordant notes curiously resemble the

squawking of hens, and for that reason it is often called "water chicken." The slightly smaller purple gallinule (*Ionornis martinica*), with handsome olive-green, purplish and bronze plumage, is found from the southern United States southward to Paraguay. Its frontal shield is pale blue and its legs bright yellow.

GALLIPOLI, a city of European Turkey, situated at the northwestern entrance to the Dardanelles. Commanding a key position to the straits, Gallipoli, strongly fortified, was the scene of much fighting between the British and the Turks during the World War. The devastating effects of the British bombardment are seen still. The surrounding district is rich in the production of cereals and fruits. Est. pop. 1928, 25,000.

GALLIPOLI EXPEDITION, a combined naval and military Allied expedition during the WORLD WAR, designed to open communications with Russia, by forcing the approaches to the Black Sea. These approaches consisted chiefly of the Turkish defenses on both sides of the Strait of the Dardanelles, i.e., along the Gallipoli peninsula and on the Asiatic coast, together with the mine fields in the strait. The attack was organized in Egypt, and set out Apr. 23-24, 1915, with four British and one French colonial division. In spite of heavy Turkish fire, landings were effected on Apr. 25 at Cape Helles, western tip of Gallipoli, at Anzac, and a "feint" landing was made on the Asiatic shore at Kum Kale. Sir Ian Hamilton established a front across Cape Helles and another inland from Sulva Bay, but the stiffness of the Turk-German defense, combined with the scarcity of reserves, forced the Allies to abandon the Dardanelles campaign in Jan. 1916.

GALLIPOLIS, a city and county seat of Gallia Co., southeastern Ohio, situated on the Ohio River, 115 mi. southeast of Columbus. It is served by river craft and the Hocking Valley and New York Central railroads. There is also an airport. The city is primarily a shipping center. The local activities include flour mills, furniture factories, brickyards and foundries. The surrounding country has many orchards and poultry farms. There are also coal mines. Gallipolis was settled in 1790 by French colonists who, before leaving France, bought land from the Scioto Land Company. Pop. 1920, 6,070; 1930, 7,106.

GALLIUM, a metallic chemical element somewhat similar in properties to aluminum; symbol is Ga, atomic weight 69.7. It was discovered spectroscopically by Lecoq de Boisbaudran in 1875. It occurs in nature mostly as minute admixtures to zinc. In the metallic form it has a bluish-grey color, melts at 30° C., then much resembling mercury, and possesses the peculiar property of contracting while melting.

GALL MITE, the common name for members of a family (*Eriophyidae*) of mites. They are so small that they cannot be seen with the naked eye, and they differ from other mites in having only four legs instead of eight. These creatures are parasites on the

leaves, buds and twigs of plants, where they give rise to galls. Some are of great economic importance because they keep the fruit from developing. Two of the most serious pests among them are the mite (*Eriophyes ribes*) which causes "big bud" on black current bushes, and the pear's leaf blister mite (*Eriophyes pyri*), particularly troublesome in the United States. Other gall mites are common on alder, ash, lime, mulberry, plum and sycamore trees.

GALLON, a standard measure of liquid capacity. The American gallon was adopted from the old English wine gallon and contains 231 cu. in. The British imperial gallon, containing 277.274 cu. in., supplanted the old English wine, ale and beer gallons of varying sizes when the imperial system of WEIGHTS AND MEASURES was introduced in 1824. The wine gallon of 231 cu. in. was first legalized in England in 1707. It was approved for use in the United States by Congress in 1832.

GALLOWAY, JOSEPH (1731-1803), American lawyer, statesman and loyalist, was born at West River, Anne Arundel Co., Md., in 1731. Early in life he moved to Philadelphia where he practiced law, gaining considerable distinction and wealth. He was early a defender of colonial rights against the crown, and served as Speaker of the Provincial Legislature of Pennsylvania. The stamp act riots of 1765 disgusted him with the more violent element among the colonists, but he became a member of the First Continental Congress, 1774, and offered a "Plan of Accommodation on Constitutional Principles," which provided for a large measure of self government in the colonies but did not call for severance of the bond with England. The plan was approved by the more conservative wing of the Congress, including Jay and Rutledge, but failed of passage. Galloway refused, however, to approve of a break with England, and upon the signing of the Declaration of Independence went over definitely to the Loyalists, writing numerous pamphlets in favor of his cause and assisting Howe in a minor post, in governing Philadelphia during the British occupation, 1777-78. In October, 1778, he went to England, living in retirement until his death at Watford, Hertfordshire, Aug. 29, 1803.

GALLOWAY PLAN, the scheme of "a Proposed Union between Great Britain and the Colonies" introduced before the First CONTINENTAL CONGRESS on Sept. 28, 1774. Joseph Galloway, the author, was a prominent lawyer and office-holder of Pennsylvania. His proposal, the last important effort to prevent revolution, provided for a federation of the American Colonies under British supervision; a president-general to be chosen by the Crown, and a grand council ("an inferior and distinct branch of the British parliament") to be composed of delegates elected triennially by the provincial legislatures. Its acts were to be subject to the veto of Parliament; but the council itself might reject acts of the British Parliament affecting the colonies. Each colony was to retain its constitution and "powers of regulating and governing its own internal police in all cases whatsoever." The plan,

supported vigorously by Edward Rutledge, John Jay and James Duane, failed of enactment by a majority of one in a vote of 11 colonies.

GALL-STONES. See GALL-BLADDER AND BILE PASSAGES, DISEASES OF.

GALLUP, a city in northwestern New Mexico, the county seat of McKinley Co., situated 168 mi. northwest of Albuquerque. It is served by bus lines, airplanes and the Santa Fe Railroad. The region produces grain, potatoes and live stock, but the principal interest is coal-mining. The city, at an altitude of 6,525 ft., lies in a region of natural beauty and archaeological interest. Near by are ice caves, lava beds, Inscription Rock, the petrified forest of Arizona and the Painted Desert. South of Gallup is Zuni City and the Zuni Indian Reservation. Gallup was founded in 1882 and incorporated in 1900. Pop. 1920, 3,920; 1930, 5,992.

GALSWORTHY, JOHN (1867-), English novelist and dramatist, was born at Coombe, Surrey, Aug. 14, 1867, and educated at Harrow and at Oxford. He practiced law for a time, but soon turned to literature as a career, his first novel, *Jocelyn*, appearing in 1898. His fame rests largely on the series of novels called the FORSYTE SAGA, and including *The Man of Property*, 1906, *Indian Summer of a Forsyte*, *In Chancery*, *Awakening* and *To Let*, 1921. In 1924 Galsworthy published *The White Monkey*, followed by *The Silver Spoon*, 1926, and *Swan Song*, 1928, a new trilogy carrying on some of the characters of the first series and depicting post-War English life; these three novels, with accompanying "interludes," were issued in 1930 as *A Modern Comedy*. Soames Forsyte, a vigorously drawn and convincing figure, centralizes the interest from the first of the Forsyte series, which was brought to close with *On Forsyte 'Change*, 1930. Galsworthy is also noted for his short stories, the finest of which appear in *Caravan*, 1925, and for his essays. His dramas, dealing chiefly with social problems, include *Strife*, *Justice*, *Loyalties*, *Escape* and *The Roof*, produced in New York in 1931. *Flowering Wilderness*, a novel, appeared in 1932. In this same year Galsworthy received the Nobel Prize in Literature.

GALT, a city in Waterloo Co., Ontario, Canada, situated on the Grand River, 57 mi. southwest of Toronto. Served by the Canadian Pacific and Canadian National railroads and supplied with excellent hydroelectric power, it is a brisk industrial and distributing center of a rich agricultural district. There are saw, planing and woolen mills, foundries and engineering works. The city was named after John Galt, secretary to the Canada Land Company from 1826 to 1829. Pop. 1921, 13,216; 1931, 14,006.

GALTON, SIR FRANCIS (1822-1911), English scientific writer and explorer, nephew of CHARLES DARWIN, was born at Birmingham, Feb. 16, 1822. From 1846 to 1852 he conducted explorations in the Sudan and in southwest Africa. Later he turned to meteorology and designed the modern method of mapping (isochrons) and, in some respects, founded the science of weather forecasting. He was the first

to apply statistical methods to anthropology and heredity, thereby founding modern eugenics. He died at London, Jan. 17, 1911.

GALTON WHISTLE, an acoustic device for producing sounds of extremely high PITCH. It is essentially a tiny, closed organ-pipe or whistle. A micrometer screw moves a plunger which varies the length of the tube, thus varying the pitch of the SOUND. The device is sometimes used by otologists for testing the upper pitch limit of hearing.

GALVANAUSKAS, ERNEST (1882-), Lithuanian statesman, was born at Vabalninkai, Nov. 7, 1882. From his early youth he identified himself with a movement to free his country from Russia. He served in the World War with the Allied armies and, after the liberation of Lithuania, was a delegate to the Paris Peace Conference, becoming also Lithuanian Prime Minister and holding other offices in the cabinet. From 1924 to 1928 he was minister to London, being also representative at The Hague.

GALVANI, LUIGI (1737-98), Italian physiologist, was born at Bologna, September 9, 1737. In 1762 he became professor there and worked upon the physiology of the birds and batrachians. By accident his attention was drawn to the effect of an electric charge upon a frog's muscle. His researches led to the first clarified exposition of the generation and conduction of electricity, his *De viribus electricitatis in motu musculari*, 1791. He died at Bologna, December 4, 1798.

GALVANIZED SHEETS, iron or steel sheets coated with zinc to protect them from corrosion. In the production of galvanized sheets the steel base is dipped in molten ZINC or spelter at about 800° F. Other zinc coatings may be applied electrolytically, or by Sherardizing in a reducing atmosphere with zinc dust, or by metal spraying (see METAL COATINGS) but they are not strictly galvanized coatings and are not generally applied to sheets. Galvanized sheets are used largely for the roofing and sides of buildings and after forming for utensils where increased corrosion resistance is desirable.

The steel sheets for galvanizing, having been annealed and thoroughly cleaned by pickling (see PICKLING OF METALS) are fed into conveying rolls which carry them through a weak hydrochloric acid solution into the galvanizing pot. A layer of zinc-ammonium chloride flux floating on the molten zinc removes the water from the sheet and cleans it further. Additional rolls carry the sheets through the molten zinc until they finally emerge from a pair of grooved and carefully adjusted exit rolls. As the sheets leave the pot they cool slowly in the air, the zinc crystallizing during solidification with the characteristic spangled appearance of a galvanized sheet. After further cooling the galvanized sheets are washed, dried, roller-leveled, inspected individually and banded.

Heavier galvanized coatings have more corrosion resistance but do not withstand forming as well as lighter coatings. The appearance of the coating may

be regulated in part by the rate of cooling. A dull finish, with no spangles, is now finding special applications. See also GALVANIZING. J. C. W.

GALVANIZING, the coating of ferrous articles with metallic zinc, may be accomplished by any one of the following methods:

The hot dip process, in which the articles are thoroughly cleaned by immersion in acid, rinsed in water, passed through a flux, carried through a bath of molten zinc, and the coating allowed to solidify. The result obtained is a coating of zinc over an iron-zinc alloy which increases in iron content until the iron is reached. The thickness of the coating is commonly designated by its weight in ounces per square foot of surface, commercial standards ranging from $\frac{1}{2}$ ounce to 2 ounces.

The electroplating process, in which the cleaned articles are immersed in a sulphate or cyanide bath and a coating of pure zinc deposited thereon. The weights of the coating usually range from $\frac{2}{10}$ to 1 ounce per square foot.

The sherardizing process, in which the clean articles are packed in zinc dust and heated, the zinc dust thereupon alloying with the iron and forming a coating of iron-zinc alloy.

The spray process, in which the cleaned articles are sprayed with molten atomized zinc. The zinc coating so obtained is somewhat less homogeneous than those formed by the other methods. It may be built up to any thickness desired. C. S. T.

GALVANOMETER, an electrical measuring instrument useful in many branches of science and engineering. Fundamentally, it is an instrument for the detection and measurement of electric current, although a form known as the *ballistic galvanometer* is well adapted to the measurement of electric charge. The instrument is one of the most sensitive of electrical devices.

In its most common form, the galvanometer consists of a light coil of wire suspended by fine, metallic ribbons. These not only support the coil in a vertical plane, but conduct electric current to it.

Within the instrument, the coil hangs vertically with its sides located in a uniform, radial magnetic field, the direction of which is perpendicular to the coil sides. Under these conditions, the passage of an electric current through the coil causes it to deflect and turn about the axis of suspension. The deflecting torque is opposed by a restoring torque due to the twisting of the suspension ribbons, aided in some cases by a light, spiral spring included as part of the lower suspension. Hence, the coil comes to rest when the two torques exactly balance each other. In better designs, the angle through which the coil turns is proportional to the current it carries.

Ballistic Galvanometers are the same in principle as the ordinary type and can be used for ordinary work. They differ, however, in that the moving coil is made relatively heavy and slow moving. If the current which passes through the instrument lasts only a short time, and has ceased flowing before the

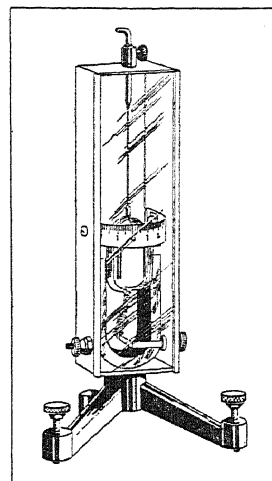
heavy coil deflects appreciably, the kinetic energy stored in the moving parts will be proportional to the integral of the current with respect to time. Thus, the maximum deflection of the coil under these conditions is proportional to the electric charge transferred. This type of measurement is commonly used in measuring capacitance and magnetic flux measurements (see CAPACITY; MAGNETISM).

Galvanometer Shunts.

In order to measure the amount of deflection, a small mirror may be mounted directly on the coil. A beam of light is projected on the mirror and reflected to a suitably graduated scale located at a known distance from the mirror. By this means, the movement of the reflected spot of light can be measured directly, and, if desired, the angle of deflection can be computed.

On account of its delicacy and sensitivity, it is very important that the galvanometer be protected from excess current. This is accomplished by means of a shunt RESISTANCE which by-passes most of the current to be measured and allows only a small fraction to pass through the galvanometer. The type of shunt commonly used is the Ayrton-Mather shunt, which, in addition to its protective feature, also combines two other important functions. The first of these is scale changing. By building the resistance with taps at proper intervals, with connections brought out to switch contact points, the fraction of the total current which passes through the galvanometer can be made any desired value. The resistance is usually tapped so that even decimal fractions of the total current can be carried through the instrument. The galvanometer shunt is also used as a means of damping the motion of the coil. This is accomplished by using a shunt of a total resistance at least approximately the same as the critical damping resistance of the instrument. The latter value is usually given by the manufacturer and is determined experimentally. It is the value of resistance which, when connected across the terminals of the galvanometer, allows the coil to return from a deflected position to its position of zero deflection in the least possible time.

The combination of shunt and galvanometer is normally connected so that the total resistance of the shunt is across the galvanometer terminals and the connection to outside circuit is between one end of the shunt and the top switch. If the shunt is of proper size, the galvanometer will then have, at all times, a resistance between its terminals approximately equal to the critical damping resistance, and it will then be



D'ARSONVAL GALVANOMETER,
STUDENT MODEL

able to deflect and return to zero without sluggishness and without oscillation. The instrument under these conditions is known as a *dead beat galvanometer*.

Purpose. Galvanometers are rarely used as calibrated instruments. Usually, a measuring circuit which involves a galvanometer contains calibrated apparatus, the constants of which are the factors which determine the final result. Thus, in the direct-deflection method for measuring capacitance, the deflection of a ballistic galvanometer when a standard CONDENSER is charged, or discharged, through it is compared with the deflection obtained when the test is repeated using the condenser of unknown capacitance. The same sort of procedure is followed in various measurements of magnetic flux. Furthermore, in bridge circuits (*see* WHEATSTONE BRIDGE) the galvanometer is used to indicate when the current through a certain part of the circuit is zero. This method of measuring, known as the *null method*, has very wide application.

Sensitivity. Although calibration is usually not important, the sensitivity of the galvanometer is very important. Sensitivity may be expressed in various ways; one of the figures often given is the current required to deflect a spot of light a distance of one millimeter on a scale located at a distance of one meter from the axis of suspension. The sensitivity of a general purpose galvanometer expressed as defined above is about 10^{-9} amperes (*see* UNITS, ELECTRICAL); very sensitive galvanometers will deflect one millimeter with only 10^{-11} amperes in the coil. Similarly, the sensitivity rating can be given in terms of the potential difference required to produce a given deflection. Ballistic galvanometers are rated in terms of the electric charge which must be transferred through the coil to produce a given deflection. W. H. T.

GALVESTON, a city on the east end of the Island of Galveston, a sand bar about 30 mi. long off the southeastern coast of Texas. Bounded on the north by Galveston Bay and on the south by the Gulf of Mexico, with an excellent natural harbor, it is one of the leading cotton and wheat ports of the United States. Its immense wharves can berth 100 ocean liners, and its warehouses and grain elevators are very extensive. In 1929 the local factory output amounted to about \$13,500,000; the retail trade was valued at \$26,893,078. Five trunk line railroads and electric interurban and bus lines connect the city with the mainland over a concrete causeway. There is a municipal airport and the airdrome of the Third Attack Group, U.S. Air Corps.

Galveston was named for either José or Bernardo de Galvez in 1782. The island later was the headquarters of the romantic Jean Lafitte, pirate and adventurer. The city has three times been swept by hurricanes; the severest storm was in 1900, when a tidal wave inundated the island, taking more than 5,000 lives and destroying \$17,000,000 worth of property. A sea wall 17 ft. high and $7\frac{1}{2}$ mi. long with a hundred-foot boulevard and promenade has since been built, defending the city from the Gulf, and the

grade of the city raised to the level of the sea wall. The commission form of municipal government, known as the "Galveston Plan," was first established here in 1901. Galveston is called the Oleander City. Pop. 1920, 44,255; 1930, 52,938.

GALWAY, a county in the west of the Irish Free State, bounded by Mayo, Roscommon, Offaby, Tipperary and Clare counties, and by Galway Bay to southward, and the Atlantic Ocean to westward. Achieving its status about 1579, Galway covers about 2,300 sq. mi. East of Lough Corrib, extending over 30,000 acres, are large bogs and west are many small lakes and the mass of granite and gneiss of the Twelve Bens or Pins reaching to 2,395 ft.

Waterways are afforded by the Shannon, Clare and Suck rivers. The countryside of Galway, sterner than in eastern counties, is marked with reminders of the Anglo-Norman conquest. Ruined castles and fortifications, and earlier hill forts and dolmens are numerous, as are ancient houses and ecclesiastical relics. Having an equable climate Galway is ideal for cattle-raising, and, with natural seaweed and limestone fertilizers, also grows considerable wheat and potatoes. Manufactures of blankets, flannels and coarse linens are largely for local consumption. Pop. 1926, 169,366.

GALWAY BAY, an inlet on the west coast of the Irish Free State, between the counties of Galway and Clare. It extends inward about 30 mi. and is 23 mi. broad at its mouth. The city of Galway, which is situated on the north shore near the head of the bay, has a fine harbor and is one of the principal western stations of Ireland fishing fleet. The Aran Islands, at the entrance of the bay, form a natural breakwater.

GAMA, VASCO DA, COUNT OF VIDIGUEIRA (c. 1460-1524), Portuguese navigator, born c. 1460 at Sines, a small seaport. He was the discoverer of the sea route to India. Gama sailed from Lisbon in July, 1497 and reached Calicut, on the Malabar coast of India, by the maritime route around Africa in May, 1498. Meeting with hostility by the ruler of Calicut, he returned to Lisbon in 1499. On his second voyage to India in 1502, he bombarded the town and the fleet and forced peace terms upon the natives. Arriving in Portugal with rich shipments, he was made count of Vidigueira and Admiral of the Indies. After living in retirement for about 20 years, Gama was made viceroy of India. He arrived at Goa in September, 1524, to assume his duties, but he died, Dec. 24, at Cochin, before he had completed his task of rectifying the abuses of his predecessor.

GAMALIEL, in early Biblical account, a prince of the tribe of Manasseh; later, the name of several descendants of Hillel, renowned Jewish rabbi. (*See* GAMALIEL I; GAMALIEL II.) Gamaliel III, who lived during the first half of the 3rd century, is famous for having reduced the Mishna of the Talmud to substantially its present shape.

GAMALIEL I (1st century), called also Gamaliel the Elder, to distinguish him from GAMALIEL II, his grandson, was a prominent Tanna, or teacher of the

Jewish Law, Nasi, or Patriarch, and first president of the Great Sanhedrin at Jerusalem. He was the grandson of Hillel, and flourished in the last few decades before the destruction of the Second Temple in 70 A.D. He was the first to bear the title of Rabban, or our teacher. The legal decisions which Gamaliel I made were generally of a lenient character, and were greatly concerned with the establishment of peace and of amicable relations between Israel and the neighboring heathen peoples, and with the welfare of the entire community. Thus his decisions permitted the heathen poor to glean in the fields, and the poor of all peoples were aided in their distress, without any discrimination.

Gamaliel I is probably identical with the Pharisee Gamaliel, the "doctor of the law," mentioned in Acts 5:34-39, who pleaded for the release of the accused apostles on the ground that if their counsel were of men, it would come to nothing, but if it were of God, none could prevent it. St. Paul, too, claimed to have been one of Gamaliel's disciples (Acts 22:3). Because of the fact that he is thus mentioned in the New Testament, many later Christian legends were related about him. It is amusing that a German monk of the 12th century called the Talmud "a commentary by Gamaliel on the Old Testament"; so strongly had the person of Gamaliel come to symbolize, to Christian minds, the old Jewish scribes.

A. SH.

BIBLIOGRAPHY.—Graetz, *History of the Jews*, 1926; Büchler, *Das Synhedrion in Jerusalem*, pp. 115-31.

GAMALIEL II (1st and 2nd cent.), called also Gamaliel the Younger and Rabban Gamaliel of Jabneh, was the grandson of GAMALIEL I, Nasi, or Patriarch, of the Jews and president of the Sanhedrin at Jabneh in the last two decades of the 1st century and at the beginning of the second century, after the destruction of the Second Temple. He was the successor of Johanan ben Zakkai in the work of establishing the academy at Jabneh on a firm basis. Unlike his rather lenient grandfather, Gamaliel II was extremely despotic in the conduct of his office, very stringent in matters concerning the Law, and anxious to preserve its unity and its literal and strict observance. He would brook no opposition or contradiction to his decisions on this score. Otherwise, however, he is said to have been compassionate. He was also a good astronomer, acquainted especially with the phases of the moon.

Tradition clustered his life and work with many legends. Gamaliel was deposed from the office of Nasi for a short time because of his tyrannical and high-handed methods. Later he was reinstated as Nasi; but Eliezer ben Azariah was accorded a share in the dignity of the office.

Succeeding Gamaliel II and his son Judah I, there were four other patriarchs by the name of Gamaliel. The last, Gamaliel VI, was the last patriarch, who held office in the reign of the emperors Honorius and Theodosius, 415-25.

A. SH.

BIBLIOGRAPHY.—Graetz, *History of the Jews*, 1926.

GAMBETTA, LEON (1838-82), French statesman, was born at Cahors, Apr. 2, 1838. As a law student and in his early legal practice he distinguished himself by his fiery republicanism and his fearless attacks upon Napoleon III. In 1869 he was elected to the national assembly. After the defeat at Sedan in the Franco-Prussian War and the proclamation of the Third Republic, Gambetta was made minister of the interior and of war. Escaping from Paris in a balloon, he directed from Tours the mobilization of the provinces in the struggle against the Germans. and, despite the hopelessness of the situation, he bitterly opposed the peace. After the war he, more than any other man, urged the republicans to assert themselves against the monarchical assembly, finally driving that body to an acceptance of the republic and the adoption of the constitutional laws of 1875. This done, he campaigned with all the power of his eloquence to bring about the election of republican deputies and senators and through them of a republican president. In this too he was successful by 1879, McMahon being forced to resign the presidency after the election of that year. Henceforward his one great aim was to keep alive the fires of patriotism and of *Revanche*. With regard to Alsace-Lorraine he told his friends "speak of them never, think of them always." As the leader of the intense nationalist group he became premier in 1881, but his many enemies quickly overthrew his ministry. He died, as the result of the accidental discharge of a pistol, at Ville d'Avray, Dec. 31, 1882.

GAMBIA, a small colony and protectorate in British West Africa, at the mouth of the River Gambia, extending inland from the Atlantic to Senegal. The total area is 4,134 sq. mi. The administration colony of St. Mary's Island covers only four sq. mi., and has 10,000 inhabitants, among whom are 250 whites. The remainder of Gambia is a protectorate.

In the savanna country beyond the river the light soil is especially good for the growing of peanuts. There is a large export surplus of this product; 70,000 tons in 1927 and an average of 60,000 tons in recent years. The small population alone cannot produce the crop, so migrant farmers from Senegal, sometimes 20,000 in number, enter the territory in the summer, rent land and share the crop with the landlord. Gambia also exports hides and palm kernels.

Bathurst is the administrative center of this territory, which is Britain's oldest and nearest African possession. The Gambia was the first British slaving area, and trading companies were established here in the time of Queen Elizabeth. There were about 200,000 inhabitants, including Jalofs, Fulani and Mandingoes, in the entire protectorate in 1921.

GAMBIA, a river of west Africa, rising in the Futa Jallon highlands of Senegal and flowing through the colony of Gambia. It enters the Atlantic at Bathurst and covers a total distance of about 1,000 mi.

The river can be ascended at all seasons by vessels for 150 mi. from its mouth. It forms an estuary ex-

panding at the entrance from 2 to 7 mi. in width. About 276 mi. above Bathurst the Gambia is blocked by the Barrakunda Rapids, which stop all further navigation from the coast.

GAMBLING. Statutes sometimes use the word "gambling," sometimes the word "gaming." The original meaning was playing games for stakes or wagers to which all the players contribute and which are to become the property of the winner, or agreements to risk money on any contest or chance where one must be loser and the other gainer. Gambling is made illegal by statutes which vary greatly in different jurisdictions. Betting, that is, an agreement that a sum of money or other valuable thing to which all the parties contribute shall be the property of one or some of them according as a question in dispute is settled in one way or the other, or on the happening of some future uncertain event, is generally not illegal, but is forbidden by statute in some jurisdictions.

GAMBOA, FREDERICO (1864-), Spanish-American novelist, was born in 1864, in Mexico, but traveled widely from early youth as foreign representative of the Mexican Government. His novels are patterned after the French realistic school. *Apariencias*, published in 1892 in Buenos Aires, was the first to win him attention outside his native country; *Suprema Ley*, 1896, fully revealed his indebtedness to PAUL BOURGET for psychology and to EMILE ZOLA for substance. For his *Esbozos contemporáneos*, a volume of sketches, the novelist was nominated as corresponding member of the Royal Spanish Academy. Gamboa represented Mexico as Secretary for Foreign Affairs at Washington, D.C., during the Huerta régime, and attracted much favorable comment by his display of diplomatic tact.

GAMBOGE (*Garcinia Morella*), a small tree of the garcinia family, native to southeastern Asia, the dried juice of which yields the gum-resin known as gamboge. The tree grows from 30 to 50 ft. high with smooth, thick, evergreen leaves, small yellow flowers and a cherry-like fruit. The reddish-orange gum, which becomes bright yellow when powdered, is used as a pigment and also in medicine for its emetic and cathartic properties. The tree is sparingly cultivated in southern Florida.

GAME AND FISH LAWS, laws passed to protect and preserve game to provide present and future hunting. The game laws introduced in England with the Norman conquest were probably the strictest ever drawn. Their purpose was to restrict the taking of game to a certain class. In England these laws still favor property owners, game belonging to the owner of the land on which it is killed. The Pilgrims in 1623 declared that all hunting and fishing was free, and this is still the basic principle of United States laws, which declare game the property of the man who kills it. Hunting is, however, subject to laws of trespass. The hunter who kills a deer may be liable for trespass if he has hunted on another man's land without permission. The owner of land which includes a

pond or lake may restrict fishing in those waters, and if he owns both sides of a stream, he controls fishing within his boundaries.

Every state has its own game and fish laws; but though the open seasons differ, especially between north and south, the basic regulations are usually the same. The same animals and birds are widely protected, and to take game fish with anything but hook and line is generally prohibited. A few states permit the spearing of such fish as suckers, eels and some of the pike family, but dynamiting and poisoning water is universally forbidden. Most states limit the number and size of fish that may be taken and establish open and closed seasons.

All states require hunting and fishing licenses, charging residents a small fee and non-residents a much larger one, especially where there is still big game. (See BIG GAME HUNTING.) This applies to the Canadian provinces. Both Federal and state laws cover the shipping and sale of game, the sportsman being entitled to possess and use those taken by himself, but usually being forbidden to sell them. Shooting after sundown is prohibited almost everywhere, except for animals such as raccoon and opossum; most states prohibit fishing and hunting on Sunday.

A summary of the fish and game laws of various states for 1930-31 is given in the U. S. Dept. of Agriculture *Farm Bulletin* No. 1647.

GAME PROPAGATION. It is now apparent that if we are to restore game to anything like its former abundance in this country, a radical change in our policy is necessary. While restrictive laws undoubtedly retard the rate of decrease of game, they do not and cannot produce game. Having depleted one of the great natural resources of the country, it is evident that in the future we must create before we destroy. The propagation of game is a comparatively new development in this country.

Game propagation may be divided into game farming and game management. Game farming, or commercial game breeding, consists of the production of game by methods similar in many respects to the breeding of poultry and live stock. The first commercial game farm was established in the United States in 1893; but it has been only during the last 10 years that game farming has assumed the proportions of an industry. The propagation of game in its natural environment, by removing the checks to increase, is termed game management. Chief among the checks to the increase of game are their natural enemies which annually take a greater toll than is killed by sportsmen. Practically all species of game are tremendously prolific and when given protection from their natural enemies, sufficient food and cover, multiply rapidly.

The propagation of game, developed along practical lines, will result in greatly increasing those species which still exist in sufficient numbers to provide ample breeding stock. Such an increase of game will provide a new and profitable crop for farmers, rural employment to thousands of our people and the as-

surance that the remaining game species will not follow the passenger pigeon into oblivion.

GAME PROTECTION. Nature endowed that part of the North American continent which is now the United States with a great variety and abundance of game. The changes brought about by the settlement and industrial development of the country have resulted in a great decrease in our game supply, which has been particularly rapid during the last century. This condition is in marked contrast to the experience of other countries where, in spite of greater density of population and other unfavorable factors, the game supply has shown a steady increase during the same period.

Efforts to protect and preserve game in the United States have been confined almost wholly to the enactment of restrictive game laws. Starting in the latter part of the 17th century, laws were enacted by the Colonies and later by the several states and the nation, regulating the time and manner of killing game and the number of each species which may be taken legally. Broadly speaking, the game protection system of the United States may be said to be a system of restrictive laws, of which we have a greater number than any country in the world. In spite of the immense volume of game legislation, the game supply of the country has been greatly reduced and several valuable species have been totally exterminated. As one of our leading game conservationists has well said, "The disquieting fact is that though game protection in the United States is now more than 200 years old, it has not protected the game."

Game Preserves and Refugees. These are private or government-owned tracts of land in which hunting is limited or forbidden, so that game animals and birds may increase. Such tracts when set aside usually already contain game in large numbers, although in some cases they are first stocked. On a number of vast estates in Europe game is thus protected and on many game birds are hatched and liberated in large numbers. The greatest game preserves in the world are those established by the English Government in Africa. These will save from extermination great herds of antelope, elephants, rhinoceros, hippopotamus, giraffes, lions and other tropical animals. The Atli Plains preserve is 200 by 40 miles in extent; the Jubaland measures 130 by 170. Another preserve in Egyptian Sudan is 215 miles long and 125 wide, and there are others almost as large.

Canadian preserves include the Algonquin National Park, 1,930 square miles well stocked with moose, caribou, bear, deer and game birds, and the Rocky Mountain preserve near Banff which contains 4,320 square miles. Alberta also includes the Glacier preserve, 2,300 square miles, and the Jasper, 5,450 square miles. Quebec has two very large preserves, the Laurentides National Park, 3,565 square miles, and the Gaspesian Forest, 2,500.

The following United States National Parks are also game preserves: Yellowstone, Wy., 2,142,700; Yosemite, Cal., 719,600 acres; Mt. Ranier, Wash., 207,

360, and Glacier Park, Mont., 915,000 acres. The following are national game preserves: Grand Canyon, Ariz., 1,402,928 acres; Mt. Olympus, Wash., 608,640 acres, and Montana National Bison Range, 18,521. There are also state preserves, the largest of which is the Adirondack State Park, N.Y., over 2,000 square miles.

There are almost a hundred national bird refugees, and almost all states have one or more. These protect the breeding places of many birds and offer sanctuary for migratory species. One of the largest American bird refugees includes Marsh Island, off Louisiana, and the Louisiana State game preserve of 13,000 acres on the nearby coast. Adjoining these is the Ward-McIlhenny Wild Fowl preserve, 11,000 acres, and a number of large private preserves. The Federal Government plans to include in its bird refuge projects many thousand additional acres of Louisiana marsh where important species of water fowl breed.

See Hornaday, *Our Vanishing Wild Life*, 1913; Stevenson-Hamilton, *Animal Life in Africa*, 1912. A list of the United States Government preserves may be obtained from the Bureau of Biological Survey, Dept. of Agriculture, Washington, D.C.

GAMES AND PLAYS. See CHILDREN'S GAMES.

GAMETE, a biological term designating the reproductive element (reproductive cell) in biparental (amphigonic) reproduction. In certain of the lower animals and plants, gametes are equal in size (isogametes); not infrequently they are unequal (heterogametes: microgamete and megagamete). In sexual reproduction the inequality is extreme, the microgamete being the male reproductive cell, i.e., the sperm cell, spermatozoon, zoosperm or spermium, the macro- or megagamete, the ovum or egg cell. See also EMBRYOLOGY; REPRODUCTION; SEX; ZYGOTE. B. F. K.

GAMMA FUNCTION. The expression $\Gamma(n+1)$ is called a gamma function, from the Greek letter *gamma* (Γ). It is defined by the equation

$$\Gamma(n+1) = n\Gamma(n),$$

where $\Gamma(n) = (n-1)!$, i.e., factorial $(n-1)$. See FACTORIAL.

GAMMA RAYS, electromagnetic waves similar to, but more penetrating than, X-RAYS. The rate at which they are spontaneously emitted by radioactive substances (see RADIOACTIVITY) cannot be influenced by any known external agency. They travel in straight lines with the velocity of light, 186,000 mi. per sec. and are uninfluenced by electric or magnetic fields (see ELECTRIC FIELD; MAGNETISM). They range in WAVELENGTH from 1.365 to 0.0047 ÅNGSTRÖM UNITS or from $\frac{1}{5 \times 10^8}$ to $\frac{1}{18 \times 10^8}$ in.

Those of shorter wave-length are the more penetrating and can only be stopped by approximately one foot of solid iron. The fraction of gamma rays which passes through an absorbing screen of a thickness d , is equal to $e^{-\mu d}$, where $e = 2.718$ and μ is the absorption coefficient (see ABSORPTION OF LIGHT). The latter constant depends on the kind of material

making up the absorbing screen and the wave-length of the gamma rays. There is a given set of absorption coefficients for any one radioactive substance, by which it may be differentiated from other active materials.

Gamma rays can act on a photographic plate to blacken it. The IONIZATION which they produce in a gas through which they are passing, measured by means of an ELECTROSCOPE or ELECTROMETER, gives a measure of their strength or intensity. They are not as powerful as ALPHA RAYS or BETA RAYS. They have a differential destructive effect on normal and pathological tissues, and, when used in large amounts, they may cause serious burning of living cells.

J. B. H.

GAND. See GHENT.

GANDHI, MOHANDAS KARAMCHAND, MAHATMA (1869-), Hindu revolutionary, nationalist and religious leader, was born in Kathiwar, India, of an old Bania family. His father was Dewan of Porbandar for 25 years and his mother was an orthodox Hindu lady who exacted a vow from her son that he would abstain from meat-eating, alcohol and women while completing his education in London. Gandhi entered London University and later the Inner Temple, becoming finally a barrister-at-law. Upon his return to India, he served successfully for some time as an advocate of the Bombay high court. In 1893, Gandhi, visiting South Africa on legal business and discovering a state of serious discrimination against the Hindus, threw himself into a campaign for the defense of their rights and worked tirelessly for many years on behalf of his countrymen in the Natal and Transvaal. At the outbreak of the Anglo-Boer War, Gandhi offered the British government the services of an Indian ambulance corps, his object being to show that Hindus could accept responsibilities as well as demand rights.

In 1903, he founded the Transvaal British Indian Association and in the following year established the Hindu newspaper entitled *Indian Opinion*. In 1906 the Transvaal government having passed an anti-Asiatic law that spelled doom to the Hindu population of South Africa, Gandhi became aroused and promulgated his policy of passive resistance which proved successful after eight years of wide-spread commotion and suffering.

Gandhi returned to India in 1914, and interested himself in the development of Nationalist activities in that country. He was prominent among those who advocated Indian cooperation with the British during the first years of the World War, accepting the British assurances that steps would be taken toward Indian self-government after the war was over. The Montagu-Chelmsford reforms of 1919 received his support, but he took the position that these did not go far enough. During this period Gandhi continued to live the life of a religious ascetic and through his writings and speeches gradually won reverence throughout India as a man of the highest moral qualities. Disappointment with what he called the

British dilatoriness in promoting Indian self-government and bitter anti-British feeling over the Amritsar incident of 1919, led him to start a campaign for passive non-cooperation with the British authorities in 1920. He bitterly attacked the British authorities following the Amritsar incident. A long campaign of anti-British activity followed Gandhi's imprisonment in 1922. The non-cooperation movement was intensified in later years by the addition of a campaign to boycott British cotton goods and, particularly, to get the people to spin and weave their own cotton cloth, using the hand looms of ancient India. In 1930 he took the lead in open defiance of the salt monopoly regulations, insisting that the Indian people should have the right to make for themselves this necessity of life. Violent attacks under British orders on followers of Gandhi in 1929-30 resulted in the intensification of Indian enthusiasm for his program of resistance and non-cooperation. Gandhi was jailed in 1930, and refused to give his approval to the round table meetings on India held in London in that year. Released in 1931, he attended the Round Table Conference in the late summer and autumn, though expressing considerable scepticism as to the possibility of actual results acceptable to India. When the 1931 Round Table Conference broke up without result, Gandhi returned to India and again launched the non-cooperation campaign. The British authorities announced that they would put down civil disobedience by any means necessary. Gandhi was again arrested, and violence broke out anew.

GANDIER, ALFRED (1861-), Canadian educator, was born in Hastings Co., Ontario, Nov. 29, 1861. He studied theology in Edinburgh and in 1889 was ordained a Presbyterian minister. After occupying pastorates at Brampton, Ont., Halifax and Toronto, he became in 1908 principal of Knox College and chairman of the Presbyterian Board of Foreign Missions. When the United Church of Canada was formed in 1927 Gandier was chosen principal of Emmanuel College.

GANDZHA, formerly Elizabethtown, a city of the AZERBAIDJAN S.S.R., on the Gandjinka River and the railroad between BAKU and TIFLIS. Turks and Armenians make up the bulk of the population, whose chief pursuits are cattle-raising and grape growing. There is an impressive, well-preserved 17th century mosque. The chief industries are cloth manufacturing, cotton cleaning and soap-making. Minerals and metals abound in the adjacent territory, a factor which has led to Gandzha's development as a shipping center for manganese, sulphur, copper and iron; cotton, honey and silk are other exports. Persians, Khazars, Arabs, Tatars, Georgians, Turks and Russians have dominated the city at various periods. Here the Persian bard, Shah Nizam, was born in the 12th century. Pop. 1926, 57,394.

GANGES, the principal river of India, flowing from the southern Himalayas into the Bay of Bengal after a course of 1,500 mi. The headstreams of the Ganges rise in Garhwal state; it draws its waters from

the Himalayas and the Tibetan plateau, by means of five great tributaries, Jumna, Gumto, Gogra, Rapti and Gandak; and in a much less degree from the Dekkan edges in the Chambal, the Son River and other feeders.

Between the northern mountain barrier of India and the edges of the Dekkan, and stretching from the Sulaiman Mountains to the highlands of Burma is a vast tract of rich alluvial soil 1,600 mi. long by 300 wide, known generally as the Ingo-Gangetic Plain. It is narrowed where the spurs of the Aravalli Hills and the sands and stones of the Thar Desert just north and east towards the Himalayas and where a slight elevation less than 1,000 ft. above sea level forms the watershed between the basin of the Ganges and that of the Indus. About midway in this narrowing of the plains stands DELHI, on the right bank of the Jumna, commanding both basins and the way from one to the other.

The Ganges enters the plain at the sacred city of Hardwar, 1,100 mi. from the sea, with the river navigable all the way for vessels of considerable tonnage. At Allahabad the Jumna joins it, having flowed past Delhi and Agra. Others of the numerous left-bank tributaries are the Gunti, Gogra and Gandak, below which the river is from 3 to 4 mi. in width, flowing in a flood plain which in the wet season may be covered with water 150 mi. wide, leaving behind rich silt that renders artificial fertilizer unnecessary. Right bank tributaries are less important; the longest is the Chambal, which waters the eastern and more fertile regions of Rajputana.

About 200 mi. from the Bay of Bengal, the Ganges breaks up into the numerous distributaries of its delta, which terminates in the marshy jungle known as the Sundarbans. The Hooghly mouth is the most important, in spite of its tidal bores and shifting mudbanks that render navigation difficult. On it stands CALCUTTA, the chief port of India. Although 75 mi. from the sea, its wharfs are accessible to the largest ocean steamers. Dangerous as it is to small craft, the bore which rushes up the river at high tide helps to keep the waterway clear. Very little water from the Ganges now flows through the Hooghly, but Calcutta has water communication with the east and north of the delta. The Brahmaputra has a common estuary with the Ganges in the Meghna, which is accessible to ocean steamers as far as Gauhati; and smaller craft ply regularly up as far as Dibrugarh, 800 mi. from the sea.

The Ganges is of vast importance to India both as a source of fertility and as a highway of trade. The region between Ganges and Jumna, and that around the Ganges-Son confluence are covered with a network of irrigation canals, and riddled with multitudes of native wells that supply irrigation ditches; thus guarding against the periodically insufficient rainfall which occurs.

There are at present four chief canal systems: the Eastern Jumna Canal takes its water from the Jumna River near Fyzabad, just where the river leaves the

mountains; the Agra Canal takes its water from the Jumna River just below Delhi; the Upper Ganges Canal takes its water from the Ganges near Hardwar, where the river leaves the mountains; and the Lower Ganges Canal receives its water from the Ganges near Narora. The Hindus consider the Ganges the holiest of rivers and many thousands of pious pilgrims annually seek immersion in its waters.

GANGRENE, simultaneous death of a mass of tissues or death of a portion of the body. The affected part becomes cold, insensible, limp and functionless, and changes color. If there has been little blood in the part before death the gangrene is dry; if normally filled with fluid, moist gangrene results. Though dry gangrene does not commonly become secondarily infected by bacteria, the opposite is true with moist gangrene. Every effort must be made to prevent the dying tissue from becoming infected. Other than this, but little can be done for the condition. Excellent results in this were obtained during the World War by the use of a constant stream of Carrel-Dakin Solution (*see* CHLORINATED SODA) by means of moist gauze pads over wounds. Through this method many limbs were saved and amputation reduced to a minimum.

The causes are various. Any long-standing blockage of the flow of blood through a region will cause its death. Such a state develops following THROMBOSIS AND EMBOLISM, alterations of the blood vessels in disease or old age, injury to a large artery, extensive burns, or frost-bite. Other types of gangrene follow infection with certain specific bacteria, notably that of gas gangrene, so common during the War. *See also* NECROSIS.

GANGS, groups originally formed spontaneously and then integrated through conflict with other groups or with authority. They thrive in the interstices of society where community life has broken down. Each gang tends to be attached to a local territory within which it feels secure. Gangs, which sometimes include girls and women, but which are usually made up of males, may be either juvenile or adult. The younger groups develop into the older by imperceptible gradations. Gangs engage in random movements, games, gambling, predatory exploits, patronage of commercialized recreation, sports and athletics and indulgence in stimulants. The dominant motive in the life of the gang member is a desire for new experience or excitement. Gangs are not inherently evil but usually follow delinquent patterns because they develop in contact with vice and crime. They are demoralizing because their boy members acquire the technique of crime, disrespect for law and order, independence and a philosophy of cynicism. The children of immigrants often form gangs owing to their congested life on the streets of cities and because of community disintegration in immigrant areas. Adolescent and adult gangs are important politically in the American city where they often wield influence either as social or athletic clubs or as criminal groups.

F. M. T.

GANGUE, the valueless, earthy or non-metallic minerals usually associated with the metallic minerals of ore deposits. **PYRITE**, **PYRRHOTITE** and such other metallic minerals as are worthless may on occasion be considered as gangue. The ore is usually interspersed with gangue, and fine grinding is required to permit their separation by milling. Separation is not necessarily complete, and the types of gangue in various ores are taken into consideration when deciding on their metallurgical treatment. In **SMELTING**, an ore high in silica must have calcite and iron oxides added to it to produce a good slag, the glassy silicate which separates from the metals. If the gangue is carbonate, however, silica must be added with the oxides. If the ore already contains iron (from pyrite, for example) the oxides may not be added.

called also Solan goose. It is common along the coasts of the north Atlantic, wintering southward as far as the Gulf of Mexico and northern Africa. Adult gannets measure about 3 ft. in length; they have stout, pointed bills, webbed feet, long pointed black-tipped wings, the rest of the plumage being snowy white. Immature gannets are grayish-brown. Gannets feed entirely upon fish, plunging upon their prey from above, and are often useful to fishermen in indicating the presence of shoals. They breed in colonies, often of vast size, usually on rocky islets, laying a single chalky white egg in a rude nest of seaweed. Most of the North American gannets nest on Bird Rock and Bonaventure Island in the Gulf of St. Lawrence.

GANNETT, HENRY (1846-1914), American

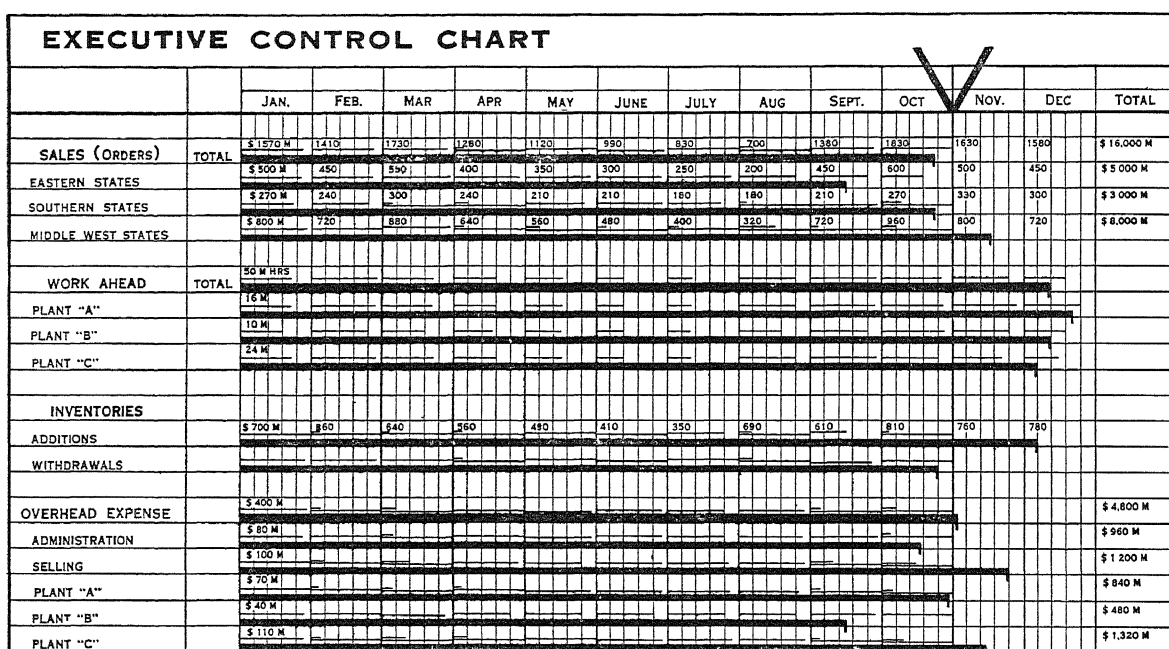


FIG. 1. GANTT CHART ENABLING EXECUTIVE COMPARISON OF PLANS WITH ACCOMPLISHMENTS

A low-grade copper ore can often be leached with acid if the gangue is high in silica. If, however, it is mostly carbonate, such as calcite, leaching would extract the gangue instead of the copper values.

Gangue minerals valueless to the metal miner may be of use in other lines. Garnet, for example, is used as an abrasive and as a semiprecious stone, and barite is employed in making paint. Quartz, calcite, barite, fluorite and siderite, with other common gangue minerals, are treated in the article on **ORE DEPOSITS**. See also **MINING**; **METALLURGY**; **ORE TREATMENT**.

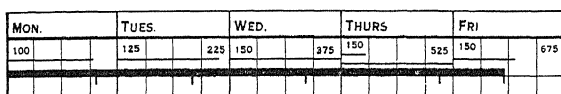
GANGWAY, a passageway in a coal mine, used as a main haulage road or level, frequently called an **ENTRY**. The gangway provides access to the mine for development and working, accommodates tracks for ore cars and conduits for electrical power, and is sometimes used as an airway. See also **MINING**, **COAL**.

GANNET (*Moris bassana*), a large sea bird of powerful flight related to the pelicans and cormorants,

geographer, born in Bath, Me., Aug. 24, 1846. He received his education at the Lawrence Scientific School and became a geographer of the United States Geological Survey in 1882. He was subsequently geographer of the 10th, 11th and 12th United States censuses, as well as of the War Department censuses in Porto Rico and Cuba in 1899. He was assistant director of the census of the Philippines in 1902 and of Cuba in 1907-08. He died, Nov. 5, 1914. Among his publications are *Manual of Topographic Surveying*; *Statistical Atlases, 10th, 11th and 12th Censuses*; *Dictionary of Altitudes*; *Commercial Geography*; *The Building of a Nation*; *Gazetteer of Cuba*; *Origin of Certain Place Names in the United States*.

GANNETT PEAK, the highest elevation in Wyoming, occurring in the Wind River Mountains in the western part of the state. These mountains are a division of the Rockies and their ridges form

Its essential feature is the presentation of facts in their relation to time. Equal divisions of space on a single horizontal line represent: equal divisions of time; varying amounts of work done. Figures show the work planned within a given time and lines drawn horizontally through a space show the relation of the work actually done to the amount planned. (See Figs. 1 and 2.)



GAON (plural, Geonim), the title given to the heads of the two great Jewish academies of Babylonia, those of Sura and Pumbeditha, in the period after the completion of the Babylonian Talmud. This period, known in Jewish history as the Epoch of the Geonim, extended from about the middle of the 7th century to the year 1038, when the last Gaon, Hai (born 969), the son of Sherira Gaon, of Pumbeditha, died.

GAPES, in fowls, a disease that attacks many wild fowls as well as domestic poultry, and is more often found in young birds. It is due to the presence of a parasitic worm (*Syngamus trachealis*) in the respiratory passages. The symptoms are gaping, sneezing and coughing and usually a discharge of mucous. Birds stand or sit with closed eyes and drooping wings and gasp for air with open mouths. Affected birds should be segregated and the pens thoroughly

sterilized. The treatment consists in removing the worms from the throat with a feather or with wire gape worm extractors, care being taken not to injure the soft membranes.

GARAY, JUAN DE (c. 1527-1583), Spanish explorer and conqueror, of noble blood, born in the province of Burgos about 1527. He went to Peru at the age of 15 in the company of his uncle, Pedro de Zarate, and served under Manso who established colonies on the eastern side of the Andes. Meeting Nufrio de Chaves coming from Paraguay, Garay passed over to his command and aided in founding Santa Cruz de la Sierra. In 1573 he established the colony of Santa Fe on the lower Paraguay River, with colonists from Asuncion. He was later named lieutenant governor and captain general of Rio de la Plata by Ortiz de Zarate, and after the latter's death was most of the time in command in Paraguay. Here he organized an expedition in 1580 to reestablish Buenos Aires, which he called La Trinidad. The location he chose proved fortunate and the new colony succeeded where the former had failed. Garay was killed three years later in an attack by Indians.

GARBAGE DISPOSAL. See REFUSE DISPOSAL.

GARBANZO, the Spanish name used in California and elsewhere in the United States for the CHICK-PEA (*Cicer arietinum*), a valuable food plant cultivated since remotely ancient times.

GARCIA, MANOEL DEL POPOLO (1775-1832), Spanish singer and music composer, was born at Seville, Jan. 22, 1775. At the age of 17 he was already famous as composer, singer, actor and conductor. At London in 1823 he founded his celebrated singing school. He wrote both words and music of his 17 Spanish, 19 Italian and 7 French operas. In 1825 he took an Italian opera troupe to the United States and Mexico. Returning to Europe after 18 months' success, the troupe was attacked by brigands, and robbed of \$30,000. He died at Paris, Jan. 2, 1832.

GARCIA, MANUEL (1805-1906), Spanish singer and teacher, was born at Madrid, Mar. 17, 1805. His musical education began with singing lessons from his father, whose opera troupe he joined. In 1829 he left the stage to teach singing. He made a profound study of the vocal organs, devising the Laryngoscope. Many treatises on the voice are based on his *Memoire sur la voix humaine*. He taught at Paris and London, JENNY LIND and MATHILDE MARCHESI being among his famous pupils. On Mar. 17, 1905, his 100th birthday, a banquet was given in his honor at London, and he was presented with his portrait by J. S. Sargent. He died at Madrid, July 1, 1906.

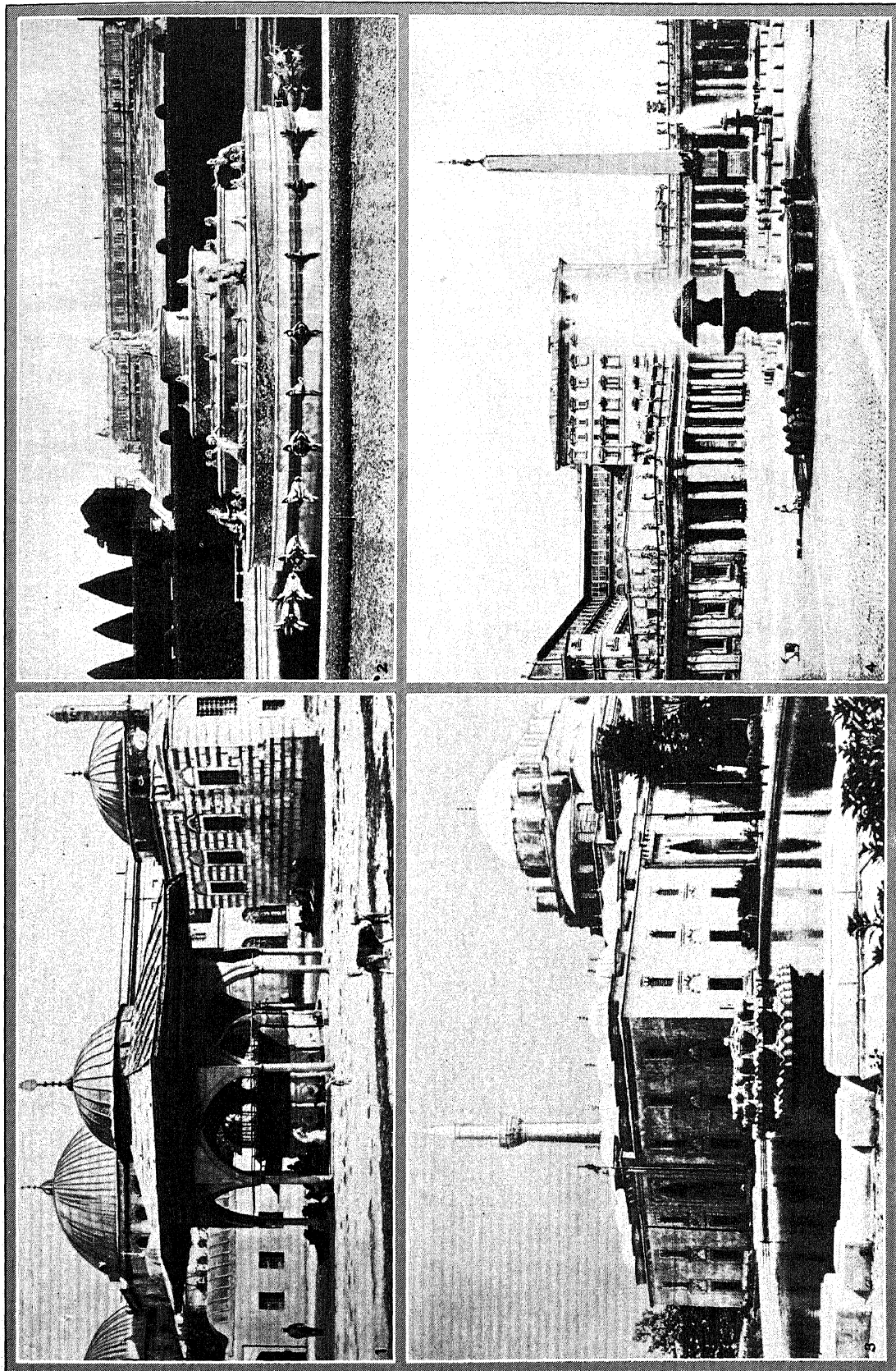
GARCIA CALDERON, FRANCISCO, a South American writer and diplomat, was born in Chile in 1883, the son of Francisco Garcia Calderon, the Provisional President of Peru. He was educated at the School of the Sacred Heart and at the University. He was appointed to the staff of the Legation in Paris, and in 1909 rose to the post of the Second Secretary of the Legation and in 1914 to that

of First Secretary. He was Minister to Belgium in 1918 and Special Envoy of Peru to the Peace Conference at Versailles. Garcia Calderon began his literary career with *De litteris*, 1904, and 3 years later issued in French his volume on contemporary Peru. He has since written many books, chiefly in French, on the sociology of Latin America, including *Men and Ideas of our Times*, *The Democracies of Latin America*, *The Past and Present of Pan-Americanism* and *The Dilemma of the War*. Garcia Calderon is considered one of the leaders of Spanish-American youth.

GARCIA MORENO, GABRIEL (1821-75), President of Ecuador, was born in Guayaquil, Ecuador, of aristocratic Castilian parents. He graduated in 1844 from the University of St. Thomas in Quito and at 33, after having been active in politics and journalism in Ecuador, perfected his studies in mathematics and physics in Paris. From 1856 to 1857 he was rector of the University of St. Thomas and mayor of Quito. As head of the provisional government established in Quito he took up arms in 1860 against Peru, which had taken Guayaquil, and freed the city, following which he gained control of the entire republic. A constitution was framed in 1861 according to his ideas which included direct and universal suffrage, and in the same year he was elected President. In 1862 he signed a concordat with the papacy which gave the Church greater powers than it had ever had in any part of America. Garcia Moreno steadily promoted the economic and material welfare of his nation, fostering improved communication, education and agriculture. But there were repeated Liberal insurrections, and his methods became more tyrannical as opposition increased. In 1865 Moreno surrendered the presidency to one of his followers and went abroad on diplomatic missions. As a result of a chaotic situation in 1869, however, he again took control and was elected president. He dedicated the republic to the "Sacred Heart of Jesus" in 1873. Re-elected in 1875, he was assassinated on Aug. 6 of that year. P. V. S.

GARCINIA, a numerous genus of tropical trees of the garcinia family (*Guttiferae*). There are about 150 species confined to the tropics of the Old World. All bear glossy, laurel-like, leathery leaves, white, pink or yellow flowers arranged in clusters and a hard, berry-like fruit, the seeds of which are embedded in a pulpy aril. The stems yield, in varying quantities, a yellow resinous juice. The MANGOSTEEN (*G. Mangostana*) is widely grown for its delicious fruit. Commercial GAMBAGE is obtained from several species.

GARDA, LAGO DI, 210 ft. above sea level, the largest of the north Italian lakes, 34 mi. long, 3 to 11 mi. broad, 140 sq. mi. in area, and having a greatest depth of 1,135 ft. Its chief feeder is the Sarca and its effluent the Mincio River. The valley of the Adige River is separated from the east bank by Monte Baldo, 25 mi. in length and 7,280 ft. high. The west bank expands between Gargnano and Salo into the



EUROPE'S CELEBRATED FOUNTAINS

1. The covered fountain in the courtyard of St. Sophia, Constantinople.
2. Fountain of Latona in the gardens of the palace at Versailles.
3. Fountain outside the mosque of the Sultan Bayezid, Constantinople.
4. Fountains outside St. Peter's and the Vatican, Rome.

beautiful "Riviera," the warmest region on the lake with many villages and country houses. Gardone Riviera, in a sheltered site on the lake at the foot of the hills, is a favorite autumn and winter resort. To the south is the promontory Sirmione, the ancient *Sirmio* of Catullus, with sulphur baths and good hotels. The finest part of the east bank is between Torri and Garda, which picturesque little town gives the lake its name.

GARDEN, MARY (1877-), American singer, was born at Aberdeen, Scotland, Feb. 20, 1877. Coming to America at six years of age, she studied the violin and piano. She worked with Fugere in Paris, and in 1900 appeared at the Opéra-Comique as Louise, singing the rôle for 100 performances. Her American début was in 1907. She was director of the Chicago Opera Company during 1921-22, and in 1929 created the title-rôle in *Camille* by the American composer, Hamilton Forrest. Her interpretations in modern French opera have been widely praised.

GARDENA, a township of southwestern California, in Los Angeles Co., situated on the Pacific Electric railway, about 12 mi. south of Los Angeles. It is in an extensive agricultural region, and has drug factories. The Spanish-American Institute is located here. Pop. 1930, 15,969.

GARDEN CITIES. See TOWN AND CITY PLANNING.

GARDEN CITY, a city in southwestern Kansas, the county seat of Finney Co., situated on the Arkansas River, 190 mi. west of Hutchinson. Bus lines and the Santa Fe Railroad afford transportation. There is a municipal airport. The city is in a rich agricultural and live stock-raising region, and at the center of the irrigation system of southwestern Kan. Alfalfa, sugar beets, grain and vegetables are grown extensively. There is a sugar factory and a poultry, egg and butter packing plant in the city. A noteworthy municipal swimming pool has been recently built. Garden City was founded in 1878 by C. J. ("Buffalo") Jones, and was incorporated in 1883. Pop. 1920, 3,848; 1930, 6,121.

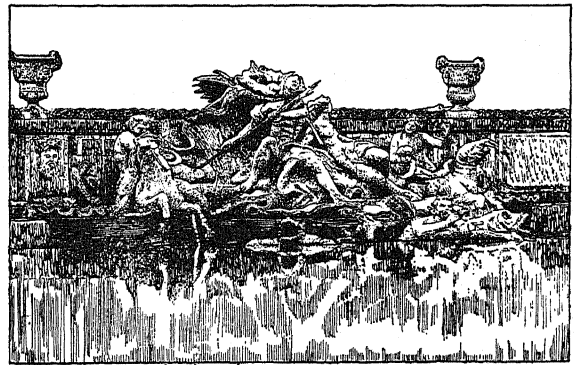
GARDEN CITY, a restricted residential suburb and village of Nassau Co., situated on the western end of Long Island, N.Y., 20 mi. from Manhattan. It is served by the Long Island Railroad. Doubleday, Doran and Co., Inc., publishers, afford the chief industrial activity here. Garden City is the seat of the Protestant Episcopal Cathedral of the Incarnation, and of the Cathedral Schools of St. Mary's and St. Paul's. Pop. 1920, 2,420; 1930, 7,180.

GARDENIA, the florists' name for the Cape-jasmine (*Gardenia jasminoides*), a native of China, and its cultivated varieties. It is an elegant shrub, 2 to 6 ft. high, with thick, sometimes variegated, evergreen leaves and large, fragrant, often double, camellia-like, white flowers. Winter blooming varieties are among the most popular of florists' flowers in the north. In the south, where it is planted for hedges, it blossoms from May to September; some forms are hardy as far north as Virginia.

GARDEN OF THE GODS, a scenic region in Colorado near Colorado Springs, noted for its fantastic rock formations and magnificent vistas of PIKE'S PEAK. The garden comprises about 500 acres and is strewn with grotesque figures in red and white sandstone eroded through the ages by wind and water. The entrance to the garden is guarded by two huge red rocks 330 ft. in height which scarcely permit a vehicle to pass between them. At one side of the entrance are the Kissing Camels. Other rock formations in the garden are known as the Dutch Wedding, Cathedral Spires, Siamese Twins, Seal and the Bear and Balanced Rock, a great boulder 71 ft. in height on an apparently insecure foundation. The Garden of the Gods is just off the National Park-to-Park Highway.

GARDEN SCULPTURE. Fountains, bird baths, sundials, urns, and statuary representing young children, animals and quaint mythical woodland creatures are favorite types of garden sculpture. The placing of pieces of sculpture in a garden should accentuate a definite plan of paths, walks, hedges, and the form of flower beds so that they assist in making the garden pleasing in winter as well as in summer.

The most famous gardens in the world are those of the palace of Versailles in France designed by Andre Le Notre. These extremely formal gardens have a wealth of Renaissance sculpture. The Basin of Neptune, the largest of the grand fountains, has



THE BASIN OF NEPTUNE, VERSAILLES
By Adam Aini, 1740

several avenues leading down to it, each lined with sculpture. The gardens of the summer palace of San Ildefonso are famous for their 26 sculptured fountains. The fountain representing Perseus and the Dragon shoots a jet of water 31 yards into the air. The jet of La Fama rises to 35 yards and can be seen from Segovia.

In the large formal gardens which were the scene of elaborate Elizabethan fêtes wooden figures of animals bearing a coat of arms seemed to be the favorite sculptural decoration. The gardens of Henry VIII at Nonsuch in Surrey had over 140 griffins, dragons, bulls, greyhounds, lions and leopards, each with a shield bearing the arms of the king and queen. France and Italy also had heraldic animals decorating their

gardens Four of these animals in bronze which were formerly in the gardens of the Medici are now in the Bargello in Florence.

GARDINAS or **GRODNO**, a town of Poland in the voievodship of Bialystok, situated northeast of Warsaw on the River Nieman. Gardinas gained its historical fame in 1793 when it was the scene for signing the treaty involving the record partition of Poland. (See **POLAND**, **HISTORY OF**.) The inhabitants engage in making and selling tobacco, liquors, machinery, soap and candles. Pop. 1930, 34,900.

GARDINER, SAMUEL RAWSON (1829-1902), English historian, was born at Ropley, Alresford in Hampshire, Mar. 4, 1829. After a preparatory education at Winchester, he entered Oxford, studying at Christ Church, and later receiving a fellowship to All Souls in 1884 and to Merton in 1892. He was for a time (1877-85) professor of modern history at King's College, London, returning to Oxford in 1886 to be examiner in history, a position he held for three years. A descendant of Cromwell, he made an exhaustive study of the period of the Puritan revolution, and became author of several historical works. Whatever he wrote was founded upon the closest investigation, and he spared no pains in his researches, examining manuscripts in private and public collections. His style is clear, direct, and not given to the pictorial, though he does, on occasion, write extremely well. He is eminently fair and has a keen sense of moral values. His general works include: *Prince Charles and the Spanish Marriage* (1869); *Outline of English History* (1887); *Constitutional Documents of the Puritan Revolution, 1625-1660* (1889); *Student's History of England* (1890-91); *What Gunpowder Plot Was* (1897); *Oliver Cromwell* (1901). He died in London, Feb. 23, 1902.

GARDINER, a city in Kennebec Co., in southwestern Maine, situated on the Kennebec River, 6 mi. south of Augusta; served by steamships to Boston and connected with two railroads. Gardiner is a market for poultry, fruit and dairy products; it has lumber, shoe and paper mills. Founded in 1754, the site was a part of Pittston until it was separately incorporated in 1803. The city was chartered in 1849. Pop. 1920, 5,475; 1930, 5,609.

GARDNER, a city in Worcester Co., northern Massachusetts, situated 15 mi. west of Fitchburg and 28 mi. north of Worcester. It is served by the Boston and Maine Railroad, bus lines and an airport. Gardner is an industrial city, manufacturing furniture, children's sleds and carriages, clocks and foundry and machine products. In 1929 the retail business reached a total of \$6,065,641. The region engages in poultry-raising and truck farming. In 1785 Gardner was founded and named for Col. Thomas Gardner, the land being taken from four communities. The city was incorporated in 1923. Pop. 1930, 19,399.

GARFIELD, HARRY AUGUSTUS (1863-); American educator, was born at Hiram, O., Oct. 11, 1863, the son of James A. Garfield, 20th President of the United States. He graduated at Williams College,

1885, and he studied law at Columbia, Oxford and at Inns of Court, London. From 1888-1903 he practiced in Cleveland where he was prominent in civic affairs. The following five years Garfield was professor of politics at Princeton, and in 1908 was chosen president of Williams College. President Wilson made him fuel administrator in 1917, and in 1920 he became chairman of Williamstown Institute of Politics.

GARFIELD, JAMES ABRAM (1831-81), 20th President of the United States, was born at Orange, Cuyahoga Co., Ohio, Nov. 19, 1831. His father, Abram Garfield, a farmer who died in 1833, was of English Puritan descent, and his mother, Eliza Ballou Garfield, was of Huguenot ancestry. The future President, the youngest of four children, spent his boyhood on the Garfield farm, attending the district school when weather and county finances permitted its session. He left the farm when 16 and journeyed on foot to Cleveland, Ohio, where he obtained work as deck-hand and driver on a boat plying the Ohio Canal. Realization that without an education he would likely remain a canal boatman all his life sent him home after two years, determined to become a teacher. By devoting every spare hour to menial tasks, he worked his way through Geauga Seminary at Chester, Ohio, and in 1851 entered the Western Reserve Eclectic Institute (now Hiram College) at Hiram, Ohio. Three years later Garfield entered Williams College, and in 1856 was graduated with honors. He was appointed instructor in classical languages at Hiram, and was elected president of the institution in 1857. The following year he married Lucretia Rudolph. Part of his growing academic renown was due to his sermons, preached as an unordained minister of the Disciples Church. Despite added duties, Garfield in the next four years found time to study law.

Political Career. Academic activities were only a stepping-stone in Garfield's career. In sermons and addresses he had expressed his vigorous anti-slavery stand, and he participated in the Hate campaigns of 1857 and 1858. In 1859 he was elected to the Ohio Senate. Two years later he was admitted to the bar and the same year, upon the secession of the cotton states, Garfield became an ardent supporter of Lincoln. He immediately volunteered, and was commissioned a lieutenant-colonel with the 42nd Ohio Volunteers. After service in Kentucky, Garfield was promoted to brigadier-general of volunteers in 1862. The same year he fought at Shiloh, and in 1863 was chief of staff of the Army of the Cumberland, and was promoted to major-general of volunteers for gallantry at Chickamauga. Later in 1863 he resigned his commission, following election to the national House of Representatives. In the lower house Garfield became an extreme Republican and his work won him the leadership in the House, where there was scarcely an issue in which he was not represented. An ardent exponent of "sound money," he was also regarded as an authority on tariff, education, and constitutional law. His speeches covering a period of 17 years in the House (to which he was reelected eight times)

have been described as constituting an authoritative political history of the times. In 1880 Garfield was unanimously elected by the Ohio legislature to the United States Senate and the same year he led the State delegation at the Republican National Convention at Chicago. The Republican outlook was not encouraging. Scandals of the Grant administration, the "Salary Grab" of 1874, and the Credit Mobilier transactions (in which the charges against Garfield were never established) had aroused nation-wide resentment against the party in power. At the Convention, Garfield proposed the name of John Sherman and opposed the "Stalwarts'" attempts to nominate Grant for a third term. On the cry, "Anything to beat Grant," a majority of delegates on the 36th ballot nominated Garfield. The ensuing campaign was extremely bitter. Although he lost ground in the West where the forged "Morey letter" showed him ostensibly opposed to Chinese exclusion, Garfield won 214 electoral votes, as compared to 155 for the Democratic candidate, General W. S. Hancock. He took office in March 1881.

Administration. The opening months of Garfield's administration were complicated by the claims of Senators Conkling and Platt to patronage control in New York State. On July 2, 1881, while waiting at the Baltimore & Potomac Station, Washington, for a train to New England, Garfield was shot by Charles J. Guiteau, a disgruntled office-seeker. The President lingered in great pain at Elberon, N.J., where he had been taken to avoid the heat and malaria which existed in Washington, and died Sept. 19, 1881. Following funeral services in the House of Representatives, Garfield was buried at Lake View Cemetery, Cleveland, Ohio.

Garfield was the father of one daughter and four sons, Harry Augustus Garfield (1863-), who became president of Williams College in 1908; James Rudolph Garfield (1865-), secretary of the interior in 1907-09; Irvin McDowell Garfield (1870-), lawyer, and Abram Garfield (1872-), architect.

BIBLIOGRAPHY.—Theodore Clarke Smith, *Life and Letters of James A. Garfield*, 1925; W. M. Thayer and E. S. Ellis, *Life of Garfield*, 1927.

GARFIELD, JAMES RUDOLPH (1865-), American statesman and lawyer, was born at Hiram, Ohio, Oct. 17, 1865, the son of James A. Garfield, 20th President of the United States. After graduation from Williams College, he studied law and in 1888 began practice at Cleveland, Ohio. A Republican, he was a member of the Ohio state senate, 1896-99, and of the U.S. civil service commission. As commissioner of corporations in the department of commerce and labor, 1903-07, he conducted important investigations during 1905-06 for the government into the practices of the meat-packing industry, coal-mining and the Standard Oil Company. He served as Secretary of the Interior in President Roosevelt's cabinet 1907-09, actively furthering Roosevelt's conservation program in addition to a complete reorganization of the department with noted improvement in the administration

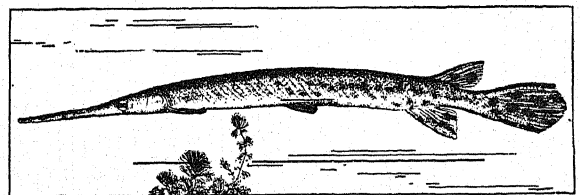
of the public land-office. In 1909 he resumed law practice in Cleveland. An ardent admirer of Roosevelt he was prominent in the formation of the Progressive party in Ohio during 1912 and in the promotion of Roosevelt's candidacy for the presidency.

GARFIELD, a rapidly growing and largest city of Bergen Co., N.J., located on the Passaic River facing Passaic and 12 mi. west of New York City. Its transportation facilities include the Erie, Lackawanna, and New York, Susquehanna and Western railroads and motor bus lines. There are a number of important manufacturing establishments, the products of which include paper, woollens, and chemicals. In 1929 the factory output reached approximately \$24,000,000; the retail trade amounted to \$6,891,297. Garfield was founded in 1881, incorporated as a borough in 1898, and received its charter as a city in 1917. Pop. 1920, 19,381; 1930, 29,739.

GARFIELD HEIGHTS, a city of Cuyahoga Co., Ohio, in the Cleveland metropolitan area, served by the Cleveland and Bedford post-offices on the Pennsylvania, the Wheeling and Lake Erie, and the New York Central railroads, and connected with Cleveland by the Cleveland Railway Co. and a motor bus line. The city is both residential and industrial. Building permits amounted to \$1,267,550 in 1929. Manufactures include building supplies, chain hoists and castings, and chemicals. The retail trade in 1929 amounted to \$1,340,000. Originally part of Newburgh, the name was changed to Garfield Heights in 1919. Pop. 1920, 2,550; 1930, 15,589.

GARFIELD MONUMENT, an imposing memorial to President James A. Garfield, erected in Lakeview Cemetery, Cleveland, Ohio. It was built of native Ohio sandstone and consists of a circular tower 180 ft. high and 50 ft. in diameter and a chapel the interior of which is richly decorated with golden mosaics and colored marble. In the chapel is a statue of the President and a crypt containing the sarcophagus.

GARFISH (*Belone*, *Tylosurus*, etc.), called also needlefish, hound-fish, greenboner, and agujon in the West Indies, are found in warm and tropical seas. They have powerful, narrow, compressed bodies, sometimes from 4 to 5 ft. long, with both jaws elongated



GARFISH

into a tapering, sharply toothed beak. Frequently, they are seen skimming the surface of the water, and are lifted completely above it at short intervals, like a silver flash, by a motion of the tail. They feed on other fishes and are themselves good food fish, although they have little popularity in the market, due

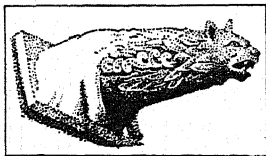
to their green bones. The best known European garfish (*B. vulgaris*) is called longnose. American garfish sometimes wander as far north as New Jersey. The needlefish (*Tylosurus notatus*) is the most common American gar and is greatly disliked by fishermen because of the damage it does to their nets. There is a resemblance between garfish and gar pike but no relationship.

GARGANTUA AND PANTAGRUEL, a remarkable social and political satire in French prose by FRANÇOIS RABELAIS, in five books, published 1532-64. The rollicking first book of this extraordinary work is generally considered the best, embodying as it does Rabelais' most important ideas on education, war and monasteries, and deals with the life of the giant Gargantua, son of Grangousier, his birth, childhood, education and remarkable adventures, including his wars against Picrochole, the great deeds of Jean des Entommeurs, and the founding of the abbey of Thélème. Book 2 treats of the adventures of Pantagruel, son of Gargantua, and introduces the intellectual, unprincipled Panurge. The third book is made up of Panurge's researches and inner debates on marriage. And Books 4 and 5 deal with a visit to the Oracle of the Holy Bottle. Perhaps the greatest English translation of this unique work is that of Urquhart and Motteaux, 1653-64, revised and edited by A. J. Nock and C. R. Wilson, 1931.

GARGET (*Contagious Mammitis*), a contagious disease of cows usually spread through the hands of milkers. The infection is caused by a streptococcus which reaches the animal through a teat, causing the teat to harden and inflammation and often suppuration to set in. The milk lessens, then becomes watery and thin, and finally yellowish and thick, containing large amounts of pus.

Garget may be prevented by thoroughly sterilizing the milkers' hands and it usually can be cured by injecting a mild antiseptic into the teat after each milking.

GARGOYLE, a projecting waterspout, often carved in grotesque form, usually with a rampant animal from whose mouth the water spouts. Symbolically, the grotesque gargoyle signifies the expulsion of the evil spirits from the sacred edifice. The word is often incorrectly used to describe any grotesque animal carving on a church exterior.



GARGOYLE FROM THE CATHEDRAL OF NOTRE DAME, REIMS

GARIBALDI, GIUSEPPE (1807-1882), Italian patriot and military hero in the struggle for Italian freedom, was born July 4, 1807 in Nice, France. Coming under the influence of Mazzini he took part in an insurrection in Genoa in 1834, fled to France and later to South America where he fought brilliantly for the new republic of Uruguay. When the news of the Italian uprising of 1848 reached him, he returned to fight for the liberation of Italy. After the defeat of the Italians in Lombardy by the Austrians

in the summer of 1848, Garibaldi joined Mazzini in Rome and they set up the Roman Republic (1849). They were driven out by French troops and Garibaldi narrowly escaped being caught by the Austrians as he was hunted like a fugitive through the Romagna. But he eluded his enemies and got away to exile.

Upon the outbreak of the war against Austria in 1859 Garibaldi again joined Sardinia in the national cause. After the peace however, he continued to agitate for independent action on the part of the Italians themselves, and organized a small force of about a thousand volunteers at Genoa for an attack against Naples. The expedition sailed for Sicily in three ships and, with the aid of the patriots there, conquered the island, crossed to the mainland and marched to Naples, the Neapolitans everywhere acclaiming him as a deliverer. In Nov. 1860 Sicily and Naples voted by plebiscite to join north Italy to form the Kingdom of Italy. After that he retired to his island home of Caprera. Always restless, however, and resentful that Rome was not a part of the new kingdom, he organized two unsuccessful expeditions to seize it before it was finally added to Italy in Sept. 1870. In that year Garibaldi volunteered to fight for the French Republic against the Germans. He died June 2, 1882, at Caprera.

GARLAND, HAMLIN (1860-), American novelist, was born near West Salem, Wis., Sept. 16, 1860. After an interval of teaching in Illinois and farming in the Dakotas, his desire to write took him to Boston where he began to publish stories. In his first group of books he depicted realistically American farm life. These included *Main-Traveled Roads*, 1890, *A Little Norsk*, *Prairie Folks*, *Crumbling Idols* and *Hesper*, 1903. His later books emphasize the beauty of the open prairie and the romance of the pioneer. The autobiographical *Son of the Middle Border*, 1917, was followed by *A Daughter of the Middle Border*, 1921, *The Book of the American Indian*, 1923, *Back Trailer of the Middle Border*, 1926, and *Companions on the Trail*, 1931.

GARLIC (*Allium sativum*), a small perennial plant of the lily family closely allied to the common onion and native probably to southern Europe. It has been cultivated since ancient times for its bulbous root, extensively used in southern Europe and in most oriental countries as a seasoning in salads and stews. The strong-odored, pungent-tasting bulb is composed of several small bulblets, known as cloves, enclosed within a whitish skin. From the bulb grow flat basal leaves and a slender flower-stalk, 1 to 2 ft. high, bearing a dense spherical cluster of long-stemmed pinkish flowers, interspersed with numerous small bulblets. The oil of garlic is valued in medicine. (See ALLYL ALCOHOL.)

GARNER, JOHN NANCE (1869-), American public official, was born in Red River Co., Tex., Nov. 22, 1869. He received a limited education but studied law for himself and was admitted to the Texas bar in 1890. Some years later he entered Democratic politics and from 1898 to 1902 he sat in the

Texas House of Representatives. In the latter year he was elected to the National House of Representatives from the 15th District and has carried this district at all congressional elections to the present (1931). On the opening of the 71st Congress in the fall of 1931 the Democrats had secured control and elected Garner to the Speakership. He was nominated in July 1932 for Vice-President and was elected in November.

GARNET, rock-forming silicates of fairly frequent occurrence, belonging to the class of semiprecious GEM STONES. Red is their usual color but brown, yellow, green and black are also common. This range of color is due to differences in composition and to impurities. Garnets are transparent to opaque. They are found as grains and crystals in metamorphic rocks, SERPENTINES and IGNEOUS ROCKS. Chemically they are silicates of magnesium, calcium, manganese, aluminium, chromium and iron in various proportions, crystallizing in the ISOMETRIC SYSTEM.

The most popular gem variety is pyrope because of its ruby-red color. It occurs with the diamond in South Africa, where it is sold as "Cape Ruby." Bohemia, Arizona and Colorado also produce it. Almandite, deep red to black, forms the once popular carbuncle, found in Australia, India, Ceylon, South America, Colorado and Alaska. The green demantoid is found in the Ural Mountains, Saxony and Hungary, while the yellow topazolite comes from Italy. New York, New Hampshire and North Carolina produce most of the ordinary garnets, extensively used as abrasives; they are also found in Spain. *See also* SAND; CHLORITE; GANGUE; ACCESSORY MINERALS; PETROLOGY; SANDSTONE; PERIDOTITE.

GARNETT, RICHARD (1835-1906), English librarian and author, was the son of the philologist, Richard Garnett. He was born at Lichfield in 1835, and was educated at home and at private schools. At 16 he became an assistant in the British Museum library under Panizzi, was superintendent of the reading-room in 1875 and keeper of the printed books until his retirement in 1899. He made many improvements in library methods, and was instrumental in completing the interrupted printing and publication of the general catalogue. Considered by authorities the most erudite man in Europe, Dr. Garnett carried his learning lightly and was responsible for much graceful work in belles lettres, including his *Collected Poems*, 1893; biographies of Carlyle, Emerson, Milton and others; the finely imaginative tales in *The Twilight of the Gods*; essays, editorial work and a large number of contributions to books of reference. He died at Hampstead, June 6, 1906.

GARNIER, JEAN LOUIS CHARLES (1825-98), French architect, was born in Paris, Nov. 6, 1825. During the time he studied at the École des Beaux-Arts, he supported himself by working for several established architects, among them Viollet-le-Duc. Winning the Grand Prix de Rome in 1848 he studied and travelled in Italy and Greece, returning to Paris to a position as government surveyor in 1853. In 1860 he won the competition for the notable Paris

Opera House. Among his other works, the most important are the Casino at Monte Carlo, the Observatory at Nice, the Bischoffsheim Library at Bordighera, the Hotel du Cercle de la Librairie in Paris, and the tombs of the musicians Bizet, Offenbach, Massé, and Duprato. He was one of the directors of the École des Beaux-Arts from 1879 on, and he exercised a great influence on French architecture not only by his designs, but through his public-spirited work as member of art juries and boards, and in his writing. He was elected to membership in the Institute of France in 1874, and was the first architect to be made a Grand Commander of the Legion of Honor (1895). In 1886 he received the gold medal of the Royal Institute of British Architects. He wrote many books on architecture and allied subjects. He died in Paris, Aug. 3, 1898.

GARNIER, ROBERT (c. 1540-c. 1590), French dramatic poet, was born at La Ferté-Bernard, about 1540. His fame rests on his seven tragedies, *Porcie*, produced in 1573, *Hyppolite*, 1573, *Cornélie*, 1573, *Marc-Antoine*, 1578, *La Troade*, 1579, *Antigone*, 1580, and *Sedecie*, 1583, also on a tragi-comedy, *Bradamante*, 1582, and *Les Juives*, 1583, regarded by some critics as his finest production. These works are not strictly dramatic; each action is preceded by soliloquies of alarming length, the plots are bald, while the development is diffuse. Their main excellence lies in the vigor and energy of the verse, and the poet's appreciation of rhythmic verse lends a movement and flow to even the most banal situations. Garnier died about 1590.

GARNIERITE, an ORE of nickel, found principally in New Caledonia. It is a soft, friable and earthy material, varying from bright apple green to nearly white. The mineral is amorphous, showing no crystal structure, and consists of a hydrated silicate of magnesium and nickel. It is found in veins in serpentinized PERIDOTITE, and as a residual, blanket-like clay deposit. Garnierite was formerly an important ore of nickel, but the copper-nickel deposits at Sudbury, Canada, have displaced those in New Caledonia as the principal source of nickel. *See also* PENTLANDITE; SERPENTINE; ORE DEPOSITS.

GARNISHMENT, a court process generally used by creditors to attach goods, or debts due to debtors, in the hands of third persons. Garnishment may be used in two ways: either as a means of collecting a judgment, after the creditor has sued the debtor; or as a means of starting suit against an absent debtor. The garnishee, or person holding the goods of the creditor against whom the action is brought, is usually in the position of stake holder and, if judgment goes against the debtor, is required to pay the creditor the amount involved in the suit. *See also* ATTACHMENT.

GARONNE, a river flowing through southwestern France, which unites with the Dordogne beyond Bordeaux to form the Gironde estuary. The Garonne rises in the Spanish Pyrenees; its total length is 385 mi., of which 240 mi. are navigable. The principal rivers of southwestern France unite with it in drain-

ing the broad and fertile territory known as the Garonne Basin, the foremost tributaries being the Tarn which flows into the Garonne near Moissac after receiving the Agout and the Aveyron and the Lot which meets the Garonne beyond Agen. The Tarn, Aveyron, Lot and Dordogne are parallel streams flowing from the east. The Dordogne which rises in the Massif Central and drains the rich Dordogne Valley has a navigable length of 170 mi. Important southern affluents of the Garonne are the Ariège, the Arize, and the Save, all streams from the Pyrenees. Next to Bordeaux the most important city on the Garonne is Toulouse.

GAR PIKE (*Lepisosteidae*), are fresh-water fish of North America, Central America, and China. Their elongated, rounded bodies are covered with bony rhomboidal scales, running downward and backward. The jaws, extended sometimes to a narrow point, but more usually slightly blunted, are equipped with sharp teeth, each fitting into a groove in the opposite jaw; nostrils are near the end of the upper jaw. Gar pike are not edible and they destroy large numbers of other fish, seizing their prey with a reptile-like sidewise movement and placing it in a correct position before swallowing. A well known gar pike (*Lepisosteus osseus*), attaining a length of about 5 ft., ranges from New England to Texas. It can be seen idling sluggishly in shallow water, where its eggs are laid in the summer spawning season. The short-nosed gar (*L. platostomus*) is more abundant in some places and the alligator gar (*L. spatula*) occurs in the Mississippi Valley.

GARRICK, DAVID (1717-79), English actor and theater manager, was born at Hereford, England, Feb. 19, 1717. He was a pupil of Dr. Samuel Johnson at Edial and traveled with him to London in 1736. His first public appearance on the stage was made in 1741 at Lydall in Ipswich. On Oct. 19th of the same year he played Richard III with such brilliance that he obtained an engagement at Drury Lane. In 1742 he went to Dublin and in 1745 became joint manager of a Dublin theater with Thomas Sheridan. In 1747 he bought a half interest in Drury Lane theater. He married Mademoiselle Eva Maria Violette, a well known dancer, June 22, 1749. The Shakespeare Memorial Jubilee was managed by Garrick in 1769. His last appearance was as Don Felix in "The Wonder" June 10, 1776, after which he sold his interest in the theater and retired with a fair-sized fortune. Garrick played upwards of 95 parts ranging from tragic roles of Shakespeare to the extremes of low comedy as Abel Drucker in Ben Jonson's "The Alchemist" and was also a writer of successful plays. He died at London, Jan. 20, 1779 and was buried in Westminster Abbey.

GARRISON, FIELDING H. (1870-), was born in Washington, D.C., November 5, 1870. He received his A.B. degree from Johns Hopkins University and his M.D. degree from Georgetown University in 1893. He was assistant librarian in the Surgeon-General's Office from 1889 to 1922. He was

editor of the Index Medicus from 1903 to 1927, when it was combined with the Quarterly Cumulative Index and called the Quarterly Cumulative Index Medicus. He has served in an editorial capacity on this new combination. He is now consulting librarian of the Welch Medical Library of the Johns Hopkins University School of Medicine. He has written extensively, the most notable of his contributions being his *History of Medicine*. M. F.

GARRISON, LINDLEY MILLER (1864-1932), American lawyer, was born at Camden, N.J., on Nov. 28, 1864. He was educated in public schools, at Phillips Exeter Academy, and at Harvard, and received his law degree in 1885 from the University of Pennsylvania. After studying law in a Philadelphia office, he was admitted to the Pennsylvania bar in 1886. He practiced in Philadelphia until 1888, when he was admitted to the New Jersey bar, and then practiced at Camden, N.J., until 1898. He became a member of a law firm in Jersey City in 1899, and remained there until 1904. In that year he became vice-chancellor of New Jersey, remaining in that position until 1913. He was appointed Secretary of War in Wilson's cabinet in 1913, and resigned three years later when he could not persuade the President to support his program of military preparedness. Since his resignation he has practiced law in New York City. He died at Sea Bright, N. J., Oct. 18, 1932.

GARRISON, WILLIAM LLOYD (1805-79), American abolitionist, was born at Newburyport, Mass., Dec. 10, 1805. After a slight formal education, he was apprenticed for seven years to a local newspaper editor where he learned the printing trade and wrote anonymously for the paper. In 1826 he became the editor of a local newspaper, and upon its failure moved to Boston where he worked first as a journeyman printer and in 1828 as an editor of the *National Philanthropist* in which he urged several reforms. At this time he met Benjamin Lundy with whom in 1829 he co-edited the weekly *Genius of Universal Emancipation* at Baltimore. Found guilty of libel and unable to pay the fine he was jailed for seven weeks in the summer of 1830. The following fall Garrison lectured against slavery in eastern cities and in 1831 began the publication of his famous abolitionist periodical *The Liberator*. The same year he helped to draft the constitution of the New England Anti-Slavery Society and in 1833 he and others organized the American Anti-Slavery Society at Philadelphia. He continued to publish *The Liberator* until slavery was abolished by the 13th amendment to the Constitution, 1865.

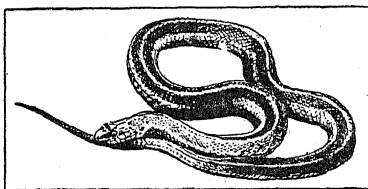
In his writing and speaking, Garrison's aggressive, uncompromising insistence upon immediate abolition and his fiery attacks upon slavery infuriated Southerners, and Northern resentment was frequently manifested by turbulent disorder at Garrison's meetings with threatened violence to him. In the decade of the 40's Garrison lamented a continuance of the Union and pleaded for the northern states to secede from the South. July 4, 1854 at Framingham, Mass., he pub-

lily burned a copy of the U.S. Constitution. During the Civil War, Garrison was at first unsympathetic to Lincoln's policies but he later heartily endorsed them. His friends in 1868 presented him with \$30,000 which had been raised to extricate him from his impoverished position. He died in New York City, May 24, 1879.

GARROTING. See CAPITAL PUNISHMENT.

GARSHIN, VSEVOLOD MIKHAILOVICH (1855-88), Russian short story writer, was born in South Russia in 1855. His three volumes of short stories were issued between 1883 and 1888. The most famous of these are *Four Days*, *The Coward* and *The Red Flower*. Most of his stories are on the border line between sanity and insanity and are filled with an unearthly beauty; in their symbolism they are reminiscent of NATHANIEL HAWTHORNE. Garshin died at St. Petersburg, Mar. 24, 1888.

GARTER SNAKE, a popular name for members of a genus (*Eutania*) of harmless snakes. There are 24 species, the more slender of which are known as ribbon snakes. The common garter snake (*Eutania sirtalis*) is probably familiar to nearly everyone in the



GARTER SNAKE

United States, Mexico and southern Canada. It is usually dark brown, green, olive or black, with three long yellowish or greenish stripes. Large specimens are about 3 ft. in length. The young, of which there may be 45 in a litter, are born alive, and are cared for by the mother after birth. This snake is very bold, and a good climber and swimmer. It eats mice, frogs, toads, fish and, occasionally, bird's eggs. Sometimes the term "garter snake" is used for other small, harmless snakes.

GARY, ELBERT HENRY (1846-1927), American jurist and business man, was born Oct. 8, 1846, near Wheaton, Ill. He practiced law, was twice mayor of Wheaton and served as railroad and corporation counsel for large industrial firms. In 1891 he was one of the organizers of the Consolidated Steel & Wire Company, in 1898 was made president of the Federated Steel Company and in 1901 became chairman of the board of the United States Steel Corporation. Gary was for 26 years of unprecedented industrial development chief executive officer of the corporation. The planning and building of the mills and the town of Gary, Ind., and the introduction of welfare measures for the employees, including stock-ownership, were a part of his achievement. He abolished the 7-day week and 12-hour day, but opposed the closed shop. He died at New York City, Aug. 15, 1927.

GARY, a city and lakeport in Lake Co., northwestern Indiana, situated on Lake Michigan, 26 mi. southeast of Chicago. It is served by lake steamers, bus and truck lines and several railroads. Gary was founded by the United States Steel Corp. in 1906. The largest steel works in the United States are here. The important industries include also tin plate, rail, cement and other subsidiary manufactures of the Steel Corporation. The wholesale trade, 1929, amounted to \$4,296,710; the retail business to \$48,256,688. The commerce of the harbor, 1929, was worth \$32,690,146. The Gary Plan or Platoon Plan, an educational system used by the city's public schools, was introduced by William A. Wirt. The Gary steel workers were leaders in the nation-wide strike of 1919. Pop. 1920, 55,378; 1930, 100,426.

GAS. See GAS FUELS; GASES, LIQUEFIED; GAS, FLOW OF; GAS ANALYSIS; GASES AND ATMOSPHERES, INJURIOUS; GAS HEAT; GAS LIGHTING; GAS MANUFACTURE.

GAS, FLOW OF. The laws governing the flow of gas through pipes or mains are the same as those for the flow of air through circular pipes of large area (see AIR FLOW). Hence, the number of cubic feet which a main can deliver per minute is directly proportional to the square root of the fifth power of the diameter of the main, inversely proportional to the square root of its length, and directly proportional to the square root of the drop of pressure within the main. See also FLUIDS, FLOW OF.

GAS, PRODUCER. See PRODUCER GAS.

GAS, WATER. See WATER GAS.

GAS ANALYSIS, the determination of the constituents in a gas mixture. It is employed extensively for controlling many industrial operations. The analysis of flue gas, for instance, enables the operator of a boiler house to effect proper burning of the coal on the grates. Another important use is the analysis of fuel gas. The knowledge of the composition of fuel gas allows one to compute its heating value from the heating values of the individual constituents. The operation of gas producers also is entirely dependent on the analysis of the product.

The mechanism of gas analysis consists of measuring an initial volume of gas, absorbing one constituent in a suitable absorbent and measuring the residual volume. The difference between initial and final volume is recorded as the amount of absorbed constituent. The ordinary gases which are determined in a gas analysis are: carbon dioxide, carbon monoxide, oxygen, hydrogen, methane, ethane, and unsaturated hydrocarbons. Methane and ethane are determined by a combustion method as there are no suitable absorbents available for them. K. K.

GAS CALORIMETER, an instrument for finding the heats of combustion (see COMBUSTION, HEAT OF) of gaseous fuels. The gas is burned at a measured rate in a burner which insures complete combustion. Coils of metal tubing, through which a steady flow of water is maintained, surround this burner. Suitable baffles prevent the escape of the products of combustion.

tion before they have reached the temperature of the outflowing water. When a steady condition is reached, the heat produced in a given time by the gas burner can be computed by multiplying the amount of water which flows through the calorimeter by the difference between the temperatures of the entering and escaping water. The Junker gas calorimeter is the one usually used in the United States. Heats of combustion of gases are usually stated in BRITISH THERMAL UNITS per cu. ft. See also CALORIMETRY.

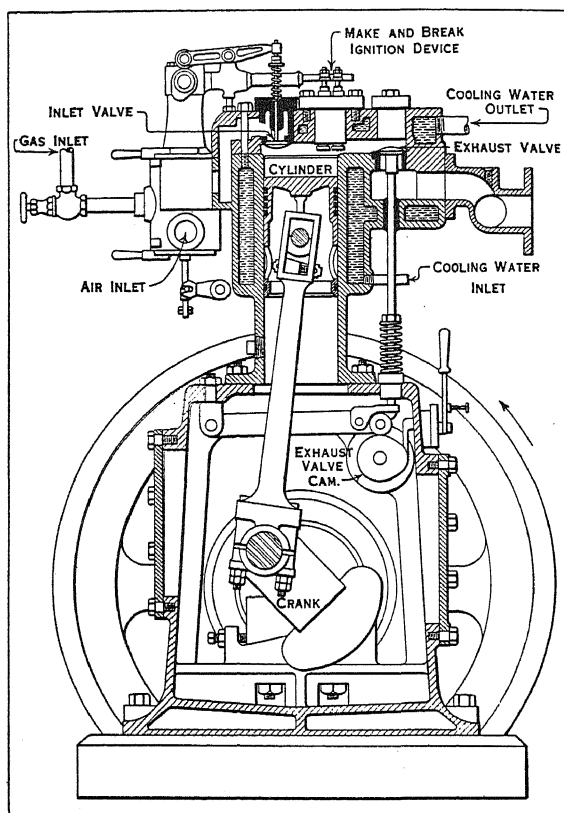
GASCOIGNE, GEORGE (c. 1535-77), English poet, was born between 1530-1535, educated at Trinity College, Cambridge, and admitted to Gray's Inn, 1555. After military service in the Netherlands, he became one of the first court poets for Queen Elizabeth. Indeed, the claim also has been made for him that in *The Steele Glas*, 1576, he wrote the first regular verse satire, the first English prose comedy in *Supposes*, 1566, and the first English translation of Greek tragedy in *Jocasta*. He died in Bernack, near Stamford, Oct. 7, 1577.

GASCONY, a duchy in southwestern France, taking its name from the Vascones, or Basques, who were driven from Spain by the Visigoths in the 6th century. Speedily absorbed by the Franks, Gascony proved a troublesome possession until finally reduced by Louis the Pious. In 1062 the hereditary ducal family died out, and Gascony became a fief of William VIII of Aquitaine, passing with that duchy into the hands of Henry II of England on the latter's marriage with Eleanor of Aquitaine. Growing restive under English rule, Gascony was put under the strong hand of Simon de Montfort in 1248. He was shortly removed on complaint of the Gascons. During the HUNDRED YEARS' WAR Gascony remained in English hands almost to the last, Bayonne being taken by the French in 1451. By the end of the century the authority of the French monarch was once more supreme in the territory.

GAS ENGINE, broadly, a type of INTERNAL COMBUSTION ENGINE in which an air-gas mixture is introduced and burned within the cylinder. The fuels may range from blast furnace gas, with a heat value of 120 British thermal units per cubic foot, through natural gas and GASOLINE to KEROSENE and the lighter distillates. Theoretically, the fuel is in the form of a GAS or VAPOR before its introduction into the cylinder; actually, however, even volatile gasoline is but partly vaporized before introduction, while the less volatile kerosene and distillate is completely vaporized only after it has absorbed heat from the warm cylinder walls.

Early engines operated at the low compression pressure of 60 to 90 pounds per square inch, since higher-compression temperatures produced pre-ignition at the then-prevailing low engine speeds. Increased speed has permitted compression pressure to be raised to 120 pounds per square inch, since the time interval per cycle has been decreased. With the development of special combustion-space designs, whereby the mass of the fuel mixture is isolated from the hot exhaust

valves and ignitor until the piston approaches top dead center, compression pressures have been raised to 180 pounds per square inch. As the efficiency depends upon the compression ratio, the desirability of high compression pressures is evident. Fig. 1 is a cross section of a typical vertical natural-gas engine. The



FROM T. W. CROFT. PRACTICAL HEAT. COURTESY MCGRAW-HILL CO.

FIG. 1. VERTICAL GAS ENGINE

Cross-sectional front view of a single-acting, four-stroke-cycle type

air and gas are mixed in an external valve chamber. Ignition is by an electrical spark between two electrodes, one of which is moved by a cam-actuated rod; the electric current is supplied from a battery and INDUCTION COIL, and the spark is made when the electrodes separate. Fig. 2 shows, in diagrammatical form, four positions of the crank and piston during a cycle of a four-stroke engine. Other engines employ only two strokes, in which event one row of ports, when uncovered by the piston, permits the escape of the burnt gases, and a second row permits the introduction of the next charge of fuel and air, which has been previously slightly compressed by a pumping mechanism.

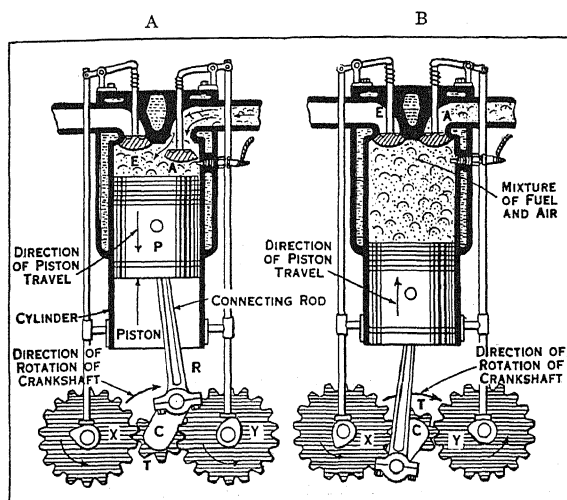
L. H. Mo.

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GASEOUS-CONDUCTOR LAMPS, essentially glass globes containing a rarefied gas and equipped with electrodes for producing an electrical discharge through the gas. Upon such a discharge the gas becomes luminous and emits light which varies in color with the nature of the gas.

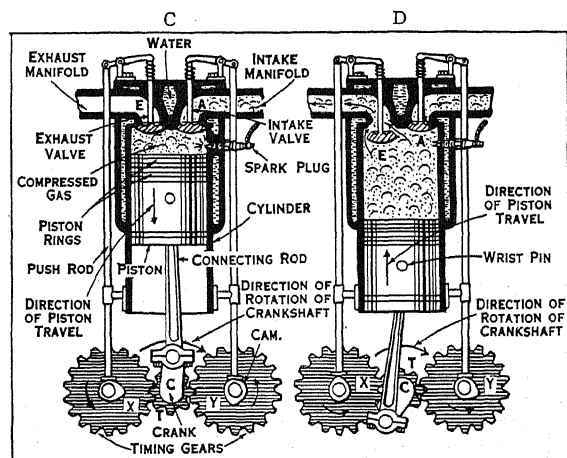
The gases in general use are neon, mercury, carbon dioxide, nitrogen, argon and helium. Each gas produces light of a distinctive and characteristic color.

Gaseous-conductor lamps are of the negative-glow or the positive-column types. The negative-glow types



COURTESY MCGRAW-HILL BOOK CO.

FIG. 2. INTAKE (A) AND COMPRESSION (B) STROKES
A, Piston drawing in a charge of fuel. B, Piston compressing the charge drawn in on the down stroke



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FIG. 2. POWER STROKE (C) AND EXHAUST STROKE (D)
C. The piston is beginning the power stroke, after ignition of the compressed gases
D. The power stroke has been completed, and the piston is beginning the exhaust stroke

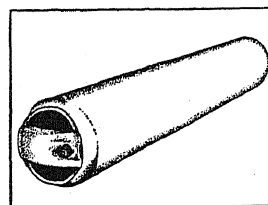
are characterized by two electrodes spaced relatively close to each other, usually in spherical globes. The light is emitted by the gas immediately surrounding the negative electrode (cathode). The positive-column types have electrodes spaced relatively far apart, usually in long tubes. The light is emitted principally by the column of gas extending from the positive electrode (anode) to a point near the negative electrode.

Each of these two classes may be divided into two sub-classes, cold cathode and hot cathode. In the

cold-cathode lamp the cathode operates below a red heat. Similarly, in hot-cathode lamps, the cathode is heated to above a red heat, either by the current or by some auxiliary source of energy. Cold-cathode lamps require a relatively high operating voltage, while hot-cathode lamps operate at lower voltages since the heated electrode emits electrons more readily. *See also ELECTRIC LAMPS; DAYLIGHT, ARTIFICIAL.* H. S. B.

GASES, LIQUEFIED, frequently known as "bottled" gases, are often handled in small steel cylinders holding approximately 100 lbs., though some are shipped in tank cars to large consumers. Among the gases so shipped are ammonia, butane, carbon dioxide, chlorine, helium, hydrocyanic acid, hydrogen, iso-butane, neon, nitrogen, nitrous oxide, propane, and sulphur dioxide.

(1) BUTANE, iso-butane, and PROPANE, known as liquefied petroleum gases, are obtained as a by-product from natural gas when it is stripped of its gasoline content. They are of increasing commercial importance as household fuels in localities where there is



COURTESY MATHIESON ALKALI WORKS
ANHYDROUS AMMONIA
CYLINDER

no piped gas service. They are also shipped in tank wagons to supply isolated community gas plants. (2) ACETYLENE, which must legally be dissolved in acetone for shipping, is used for cutting and welding metals. (3) Hydrocyanic acid is used for fumigating. (4) Nitrous oxides are used for anesthesia. (5) Ammonia is a refrigerant. (6) Carbon Dioxide is a refrigerant and is used in carbonated beverages. G. A. P.

GASES AND ATMOSPHERES, INJURIOUS.

Injurious substances may enter the body more readily and more rapidly through the lungs than through any other channel. Four to eight liters, or quarts, of air are breathed each minute during bodily rest; and five or ten times as much during the vigorous breathing of physical exercise. The air inspired comes into intimate relation with the blood in the lungs. Consequently, not only oxygen is absorbed, but any harmful substance in the air is also taken up by the blood and carried to all the tissues and organs, and especially quickly to the brain.

Simple Asphyxia. The simplest kind of injurious atmosphere is one in which the oxygen has been so far reduced, or replaced by inert gases, that it will not support life. (*See ASPHYXIA.*) Pure air contains 21% of oxygen. A candle is extinguished when the oxygen falls below 17%; a man is seriously affected below 13 per cent. This may occur in mines, silos, wells, sewers, grain elevators and the holds of ships. It never occurs in living-rooms or in even the most crowded halls or theaters; effects in such places are due chiefly to the heat, moisture, and lack of movement of the air.

Formerly it was supposed that the carbon dioxide given off in the breath would render air injurious; but it is now known that the lungs in health normally

contain 5 to 6% of CARBON DIOXIDE, and that it is the carbon dioxide in the blood acting upon the respiratory center in the brain which is the principal stimulus and control of respiration. Moderate amounts of carbon dioxide are even beneficial, in some conditions, by inducing deeper breathing. Carbon dioxide mixed with oxygen (usually 7% carbon dioxide and 93% oxygen) is now administered to the victims of asphyxia and of various kinds of gas poisoning given below; it affords the most effective means of resuscitation, and for preventing pneumonia. (*See also* RESPIRATION, ARTIFICIAL.)

Indirect Asphyxiants. The commonest form of gas poisoning is carbon monoxide asphyxia. *Carbon monoxide* is contained in the exhaust of automobiles, motor boats and other internal combustion engines (especially when the carburetor is adjusted to a mixture high in gasoline and low in air), in city gas, in coal fires operating with insufficient air supply, in smoke of burning buildings, and in the products of incomplete combustion of any form of carbonaceous material. Carbon monoxide forms a combination with the hemoglobin of the blood which displaces an equal volume of oxygen and correspondingly reduces the capacity of the blood to transport oxygen from the lungs to the tissues of the body. The attraction of carbon monoxide for hemoglobin is nearly three hundred times as great as that of oxygen; for this reason small amounts of carbon monoxide in the air breathed may result in a large part of the hemoglobin being ultimately combined with this gas. All the ill effects are due to the resulting deprivation of oxygen. In many cases the victim is rendered unable to walk and falls to the ground, or loses consciousness, before he feels any discomfort or realizes that the gas has affected him at all. (The treatment is outlined in the article on ASPHYXIA.)

Effects somewhat similar to those of carbon monoxide, but even more rapid, are induced by *hydrogen cyanide* gas, which is now often used to rid ships and houses of vermin. The action of this gas is not upon hemoglobin, but upon some constituent in the tissues essential to their utilization of oxygen.

Pulmonary Irritants. Another class of gases, which includes the fumes of various acids, as well as chlorine, phosgene, sulphur dioxide, the higher oxides of nitrogen (from burning gun powder, dynamite, celluloid, etc.), hydrogen sulphide, ammonia and most of the gases used in warfare, irritate the lungs and windpipe. Some, for example, ammonia and chlorine, erode the air passages. Others, as phosgene and nitrogen peroxide, induce pulmonary edema, an excessive secretion of watery fluid, and the victim practically drowns in this secretion in his lungs. With some gases this effect follows quickly; with others there is little immediate effect, but edema develops and death results hours or even days later. (*See also* GAS WARFARE; POISON GAS.)

Volatile Drug-like Substances. These include the substances used for surgical ANESTHESIA, various alcohols, the hydrocarbons distilled from petroleum,

and particularly benzol and related substances. The primary action of all these substances resembles alcoholic intoxication; but particular substances have, in addition, special harmful effects. Thus methanol (methyl alcohol) vapor from some varnishes may cause blindness and other nervous degenerations; and benzol, which is extensively used in the rubber industry and in some paints, has destructive effects upon the blood if breathed even in small amounts for many days. It may cause death if inhaled in a confined space, as occurs when the inside of a tank is painted.

Volatile Forms of Metallic and Other General Poisons. The effects of any general poison like arsenic, mercury, lead, etc., are much more rapid and intense when absorbed through the lungs in volatile form than when taken into the stomach. Inhalation of hydrogen arsenide from storage batteries, or of mercury vapor, may cause chronic ill health if the amounts are small. Inhalation of tetra-ethyl lead which is used as an "ANTI-KNOCK" COMPOUND in gasoline, may cause suicidal mania and death.

Dusts. The inhalation of dusts, particularly those containing quartz and other silicious materials, predisposes workmen in dusty trades to develop tuberculosis of the lungs. (*See* PNEUMOCONIOSIS.) Inhalation of the dust of lead paints is a common cause of chronic LEAD POISONING. Y. H.

GAS FLAME CUTTING, a method of cutting metals by an oxyacetylene torch. The cut is started by heating a spot with a flame of OXYGEN and ACETYLENE. When the spot is sufficiently heated, the acetylene is turned off and only the oxygen jet is directed against the spot. Under the flame the metal and the oxygen combine to form a metallic oxide. The cutting is not a mere melting of the iron but a chemical process that may be compared to a very rapid form of rusting. The hot iron really burns itself away in the oxygen and the pressure of the gas jet blows the oxide away, leaving a narrow slot or cut. Steel and iron up to several feet thick can be cut by this method. Boiler plate a quarter inch thick can be cut at about 80 feet per hour and 8-inch armor plate at about 17 feet per hour. Cutting by heat is almost always done with the gas torch but occasionally the electric arc is used. *See also* WELDING; CUTTING. F. H. C.

GAS FUELS. The principal gaseous fuels for steam generation are NATURAL GAS, coke-oven, producer and blast-furnace gases. Natural gas is supplied by nature, and is an excellent fuel, being practically free from non-combustible gases. It is found at varying depths below the surface of the earth, being confined in "pockets" under high pressure, and it is distributed to industrial and populous centers through a growing network of PIPE LINES. Natural gas is an ideal fuel for steam generation and for metallurgical furnaces owing to the absence of ash, and the ease with which it is possible to control COMBUSTION. Although the supply of this gas is rapidly diminishing in some fields, other areas are being opened up.

Coke-oven Gas. The manufacture of COKE by the by-product method is a true DISTILLATION process

Practically all of the volatile matter of the coal is distilled off, and the vapors thus obtained contain not only fixed gases, but also liquids and solids. By various methods of cooling, separation and extraction, the solids and liquids are recovered, leaving only the fixed gases. Of the gas thus obtained, approximately 50% is returned to heat the ovens, the balance being pumped to the gas main to be used as fuel for steam boilers, and for industrial or domestic purposes. The steam required in the by-product plant is usually generated by burning coke "breeze," and, sometimes part of the coke-oven gas.

Producer Gas is made by partially filling a GAS PRODUCER or GAS RETORT with coal and igniting it. Air, or steam and air, are then forced up from the bottom of the fuel bed where the non-volatile part of the coal is burning. The air and steam combine with the carbon to form CARBON DIOXIDE. This, in the presence of hot carbon, is then partially reduced to CARBON MONOXIDE, a combustible gas and one of the principal constituents of producer gas. When steam is used part of the water, in conjunction with the incandescent coke, forms carbon monoxide and free hydrogen. Some METHANE results at first from the distillation which the coal undergoes.

Blast-furnace Gas is a by-product of blast-furnace operation. As a result of the various reactions occurring in the different zones in the blast furnace, the gases leaving the top contain a relatively high percentage of carbon monoxide, along with carbon dioxide, nitrogen and water vapor. Because of the large percentage of inert gases, this gas is slow to ignite and therefore requires special burners and furnaces. But in modern steel mills a large percentage of the steam requirements is generated by burning it.

The following table indicates the composition of representative samples of the fuels described above:

ANALYSIS BY VOLUME OF GASEOUS FUELS

	Natural Gas	Coke-Oven Gas	Producer Gas	Blast-Furnace Gas
Carbon Dioxide CO ₂	.35	1.0	8.5	12.7
Carbon Monoxide . . . CO	.45	4.8	21.0	25.9
Oxygen O ₂	.30	0.0	0.0	0.0
Illuminants (such as) C ₂ H ₄	.30	3.0	.3	0.0
Hydrogen H ₂	.50	53.5	10.8	3.6
Methane CH ₄	94.00	34.0	4.1	0.0
Ethane C ₂ H ₆	0.00	0.0	0.0	0.0
Nitrogen N ₂	4.10	3.7	55.3	57.8
B.t.u. per cu. ft. at 14.7 lb./sq. in. and 32° F.	1015.	557.	156.5	100.

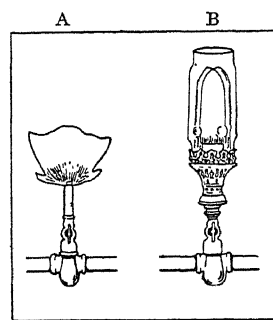
O. DE L.; K. T.

GAS HEAT. Gas is a clean and convenient fuel, and special BOILERS and FURNACES are available to take advantage of its COMBUSTION characteristics. Like oil (*see* OIL BURNERS), gas is burned under automatic control. Special heating rates are commonly offered by the gas companies, but except where natural gas is available, the cost of gas heating is high when compared to that of either oil or the solid fuels,

such as coal or coke. Both gas and oil-fired heating plants operate at comparatively high efficiencies—gas at about 80%, oil 70% to 80%, and the conventional coal-fired house-heating equipment at 50% to 65%. Gas usually is burned under specially-designed boilers, although special burners are available for installation in boilers designed for coal. *See* GAS FUELS.

GASKELL, ELIZABETH CLEGHORN (1810-65), English novelist, née Elizabeth Stevenson, was born in Chelsea, London, Sept. 29, 1810. She was brought up in Knutsford, Cheshire, and attended school at Stratford-on-Avon. In 1832 she married William Gaskell, a Unitarian minister, and later a professor in Manchester New College. *Mary Barton* was published in 1848, winning for its author the attention of Carlyle and Dickens. *Cranford*, for which Knutsford, imaginatively treated, furnished the setting, appeared in Dickens's *Household Words* as a series from 1851-53. The famous *Life of Charlotte Brontë* was published in 1857. Other works are *Ruth* and *North and South*, a story of the industrial revolution. Mrs. Gaskell died at Holyburn, Alton, Hampshire, Nov. 12, 1865.

GAS LIGHTING. The flame produced by the complete combustion of gas is practically colorless and is not suitable for illumination. It is necessary to introduce a solid substance (mantle) into the flame to secure incandescence. In the old gas burner, the fish-tail type, the nature of the combustion was such that carbon particles were present in the flame and were heated to incandescence by heat generated in the reaction. This type of gas illumination is very inefficient, however, since only 1½ to 3 candles are produced per cu. ft. of gas consumed.



A, OPEN FLAME GAS BURNER; B, WELSBACK MANTLE

Dr. Carl Auer von Welsbach of Vienna began, in 1880, to develop a mantle for the Bunsen burner. In the early nineties he introduced one composed of 99% thorium oxide and 1% cerium oxide, which is still in use. The Welsbach incandescent burner, on low-pressure, produces about 28 to 30 candles per cu. ft. of gas. *See* WELSBACK BURNER.

Higher efficiencies than this are obtained in high-pressure illumination, where the gas is supplied to the burner under a pressure of 2-3 pounds per sq. in., 50-60 candles per cu. ft. being obtained with the incandescent burner. The high efficiency of high-pressure illumination is a result of the high temperatures produced in combustion.

The first practical illumination by gas was achieved by an English engineer, William Murdock, in 1792, and the development of gas lighting took place within the 19th century. It was used for illumination for the first time in the United States in a domestic installation in Newport, R.I., in 1806. Gas lighting was in-

stalled for municipal use for the first time in Baltimore in 1817. By the end of the century both artificial and natural gas were being widely used for lighting, in municipal, industrial and domestic installations. However, with the invention of the incandescent electric lamp in the latter part of the 19th century, electricity has largely replaced gas for lighting, especially in the United States.

GAS MANUFACTURE, includes the production of a large number of combustible gases, the best known of which is the city gas so extensively used in every urban household. The most important ones are producer gas, blue water gas, coal gas, coke oven gas, carburetted water gas, and oil gas.

The constituents of industrial gases are hydrocarbon vapors, hydrogen, carbon monoxide, some carbon dioxide, and nitrogen. The compositions, of course, are widely different for the different gases.

PRODUCER GAS is manufactured in a so-called gas producer consisting of a steel shell, lined with fire bricks and containing a support for the fuel bed. In operation the top of the producer serves for the introduction of the fuel and as take-off for the gas, while at the bottom, air and steam are admitted and ashes and clinkers are removed. Producer gas is used extensively for the heating of retorts in the manufacture of coal gas.

The manufacture of **WATER GAS** is similar to that of producer gas. The generator is built like a gas producer but is operated in cycles. The fuel bed is first raised to a high temperature in the "blow" and then steam is passed through the hot fuel bed in the "run" to make the water gas. "Blow" and "run" constitute a cycle.

Coal gas and coke-oven gas are made from coal which is placed in retorts of heat-resisting material and heated to high temperature causing the decomposition of the coal and the formation of gas. The gas contains small amounts of light oil vapors, ammonia, hydrogen sulphide, and other organic compounds which are removed before the gas is ready for use. The ammonia is absorbed in sulphuric acid and sold as ammonium sulphate. Other products are the residual coke, coal tar, and light oils. The light oils, including some benzol, are recovered by means of a suitable absorption oil and in some plants by absorption in activated charcoal.

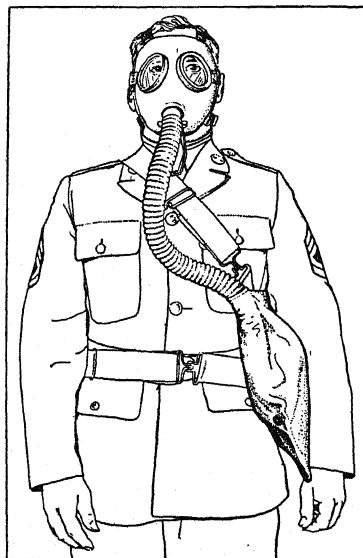
Carburetted water gas is obtained by enriching the blue water gas with hydrocarbon vapors to give it a higher heating value. It is made in a so-called Water Gas set which consists of the generator, the carburetor, and the superheater. The generator contains a fuel bed which is raised to red heat by an air blast. The products of combustion pass into the top of the carburetor and heat the checker brick work, which fills the interior, and then pass into the bottom of the superheater and out at the top to the stack. When the set is at the desired temperature the air blast is shut off and steam admitted to the generator, which in passing through the hot fuel bed forms blue water gas. The hot water gas passes to the car-

buretor into which gas oil is injected, vaporized and partly decomposed. In the superheater the decomposition is carried to the desired point and then the rich gas passes out to a purification process.

Oil gas is made in a water gas set by burning oil and air to bring the set to temperature and then injecting oil and steam into the hot apparatus, where it is decomposed into hydrogen, hydrocarbons, vapors and lampblack. The lampblack is sold as a by-product.

According to the census of 1930 there were in the United States 749 plants for the manufacture of gas for heating and illumination. These gave employment to 43,956 wage-earners and produced a total output valued at \$519,904,808. *See also* CARBONIZATION. K. K.

GAS MASK. The introduction of **CHEMICAL WARFARE** during the World War was followed by a race between armament and protection similar to the naval contest of armor and armor-piercing shell. In the case of chemical warfare, more and more effective agents were introduced and better gas masks were needed and developed as each succeeding chemical requiring greater protection was brought into the field. For the earliest gas, chlorine, ample protection



COURTESY U. S. DEPT. OF WAR

GAS MASK

was provided by comparatively simple alkaline neutralizing agents but with the improved chemical agents more effective neutralizing and absorbing properties were required. With the development of the highly toxic smokes that were introduced near the end of the war, it was necessary to develop masks that provided effective filters in addition to the absorbing and neutralizing agent. The gas mask of all powers eventually combined these factors and provided chemical neutralizing agents, highly activated carbons or charcoals and effective felt filters. *See* CARBON, ACTIVATED; SILICA GEL. H. L. G.

GAS METER, an instrument for measuring the volume of gas flowing through a line. Four types of meters are used, the "wet," "dry," rotary and orifice. The wet type has a revolving drum divided into compartments which are alternately filled and emptied during a revolution. The number of revolutions times the volume of the compartments is transmitted to a registering apparatus through a set of gears so that the amount of gas in cubic feet may be read. The dry meter, the usual type used in metering gas, for domestic use, consists of double bellows so arranged that they are alternately filled and exhausted, the number of pulsations being transmitted to counting dials. In the rotary meter a stream of gas passes through a fan wheel, the revolutions of which are recorded on the dials. The orifice meter is essentially a plate having an orifice which slows up the gas flow. Readings of the resulting pressure differences on the two sides of the orifice are taken by automatic recording apparatus and converted by tables to cubic feet of gas flow.

GASOLINE, a highly volatile liquid refined from PETROLEUM suitable for use as fuel in INTERNAL COMBUSTION ENGINES, employing CARBURETORS. The Federal specifications, effective October 21, 1931, for United States Motor Gasoline require that not less than 10% of the motor fuel be evaporated in the standard DISTILLATION test at 167° F.; that not less than 50% be evaporated at 284° F.; and that not less than 90% be evaporated at 392° F.; and that the Reid VAPOR PRESSURE at 100° F. be not over 12 lbs. per square inch. Practically all gasoline currently sold in the United States is more volatile than these specifications require. Gasolines marketed during the winter are usually the most volatile. During recent years the VOLATILITY of gasolines has shown a definite increase.

There is no generally recognized specification for the anti-knock quality of gasoline. (See ANTI-KNOCK COMPOUNDS.) Most of the gasolines marketed in the United States come within the range of anti-knock rating equivalent to 50-80% iso-octane in normal heptane.

The total motor fuel supply is provided almost entirely by gasoline made by three different refining processes. These are: Natural Gasoline, a highly volatile gasoline from NATURAL GAS. It is "blended" with heavier gasolines and contributes increased VOLATILITY and somewhat better anti-knock quality to motor fuels. *Straight-run gasoline* is produced from crude petroleum by distillation processes. It varies widely in yield and properties with the "crude" from which it is obtained. In 1929, 55.2% of the total gasoline was supplied by straight-run gasoline. *Cracked gasoline* is produced by the decomposition of heavier oils. Cracking has been largely responsible for increasing the yield of gasoline from crude petroleum. Cracked gasoline is usually more volatile and of better anti-knock quality than straight-run gasoline. In 1929, 32.4% of the total gasoline was produced by CRACKING PROCESSES.

The total production of gasoline in the United States in 1929 was 444,104,000 barrels, equivalent to

806.7 gallons per automobile. The production of gasoline has increased more rapidly than the production of crude oil. In 1920, the yield of gasoline from crude petroleum was 26.1%; in 1915, 32.4%; in 1929, 39.4%.
G. G. BR.; M. So.

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GASPEE, British ship patrolling American waters for smugglers in colonial times. Running aground near Providence, R.I., it was burned by a band of colonists, June 10, 1772.

GASPÉ PENINSULA, a headland district of eastern Quebec, extending into the Gulf of St. Lawrence. The St. Lawrence River bounds it on the north. The interior, comprising the counties of Bonaventure and Gaspé, is crossed by the Shickshock Mountains, which are densely wooded and unsettled. The inhabitants, mostly fishermen, live in villages at the mouths of the rivers. The one harbor is at the head of Gaspé Bay. This peninsula has 375 mi. of shore line which affords a valuable and almost inexhaustible fishing coast.

GAS-PLANT, in botany, a name sometimes applied to the DITTANY or fraxinella (*Dictamnus albus*). It will frequently give a flash of light if a small flame is placed under the main flower cluster on a calm dark night.

GAS PRODUCER, a device similar to FURNACES for producing gas from solid or liquid fuels by a process combining DISTILLATION and COMBUSTION. The producer comprises an air-tight steel or iron vessel, generally vertical and cylindrical, having a grate and ash pit, a deep fire pot, inlets for fuel and moist air and outlets for gas and ash. The fuel is charged from above into the fire pot, where distillation of the volatile matter takes place, as does combustion, the last mainly to CARBON MONOXIDE. The fuels used include every type of coal; other solid fuels, such as peat, sawdust, charcoal, flue cinder and briquettes; and liquid fuels, as fuel oil and tar oil. Dry air, moist air or steam may be used as the furnace blast, giving air gas, PRODUCER GAS, or WATER GAS respectively. The important chemical reaction is the union of oxygen from the air or moisture with the carbon of the fuel to produce carbon monoxide or carbon dioxide, the former having energy principally in the form of latent heat and the latter, sensible heat.

GASSENDI, PIERRE (1592-1655), French philosopher and mathematician, was born at Champiercier, Provence, Jan. 22, 1592. From 1613 to 1623 he was professor of philosophy at the University of Aix. In 1645 he became professor of mathematics at the College Royal, Paris. He attempted to attack both the old and new tendencies in philosophy and mathematics, the former with an argument leveled at the Aristotelian scholastic methods, in seven successive volumes, the first published in 1624; the latter by an attack on René Descartes which Descartes reprinted and answered in 1641. Gassendi attempted

to build a materialist philosophy, with God as the underlying first cause, by making use of the atom theories of Epicurus. He died at Paris, Oct. 24, 1655.

GASTEIN, TREATY OF, a compact between Austria and Prussia signed Aug. 14, 1865. In 1864 the two Powers had declared war on Denmark because that Power had attempted to incorporate Schleswig and Holstein, two duchies at the base of the Danish peninsula. By the treaty of peace, the King of Denmark renounced all rights to the duchies and Lauenburg to the King of Prussia and the Emperor of Austria. Thereupon the two rulers concluded the Treaty of Gastein by which both retained sovereign rights in both duchies, Austria undertook the administration of Holstein; Prussia, that of Schleswig with a military road, telegraph and postal line through Holstein guaranteed her by Austria. This unsatisfactory arrangement led to the Austro-Prussian War.

GASTONIA, a city of southwestern North Carolina, the county seat of Gaston Co., situated about 20 mi. west of Charlotte, in the heart of the Piedmont Plateau region. Two railroads, an electric railway and bus lines provide transportation. Increasing activity in the textile industries has stimulated the rapid growth of Gastonia. The city manufactures combed yarn, cotton fabrics, textile machinery and dyes; of the 104 textile plants in Gaston Co., 43 are in Gastonia. The city's factory output in 1929 was worth \$18,605,132. In 1929 the retail business amounted to \$8,723,722. The Kings Mountain National Military Park is 20 mi. west. Pop. 1930, 17,093.

GASTRIC AND DUODENAL ULCER (Peptic Ulcer). Peptic ulcer, so called because it is commonly ascribed to peptic digestion of the gastric mucosa, was recognized by the ancient physicians, but was definitely differentiated clinically into duodenal and gastric ulcer only in the early part of the twentieth century. It occurs ten times as frequently in the duodenum as in the stomach and about four times as often in men as in women. Local infections, such as tonsillitis, apical teeth abscesses and sinusitis are contributing causes. An ulcer constitution has been described and a familial tendency recognized. Recurrences are prone to appear in the spring and fall. Ulcers occur most frequently in the 3rd and 4th decade of life but may be found in the very young or very old.

The characteristic lesion occurs in the first inch of the duodenum or on the lesser curvature of the stomach as a punched out ulcer involving one or all the layers of the wall. It may perforate into the peritoneal cavity and lead to a peritonitis or erode into a large blood vessel.

The typical symptoms whether gastric or duodenal are regularly recurring pain or heart burn, occurring one to four hours after eating, often awakening the patient from sleep and relieved by food taking or alkalis. Free intervals of weeks, months or years are not uncommon. The pain is ascribed to acid gastric juice or increased spasm of the antrum and pylorus. Probably both factors are involved.

The diagnosis is made by the symptoms and the demonstration by X-ray of an ulcer defect in the duodenum or the stomach. Tenderness is found in the epigastrium in some cases.

Three complications are important. Perforation of an ulcer occurs in about 5% of cases and leads quickly to peritonitis and death unless an operation is performed in the first few hours.

Hemorrhage may be slight and is discovered only by tests of the stool for blood or be profuse and manifest itself by vomiting of blood or the passage of large quantities of tarry like stools. Fainting from loss of blood is not infrequent.

The pylorus may become closed by cicatricial contraction or spasm with resulting inability of the food to pass into the intestine. Vomiting is the commonest symptom. Inanition frequently results.

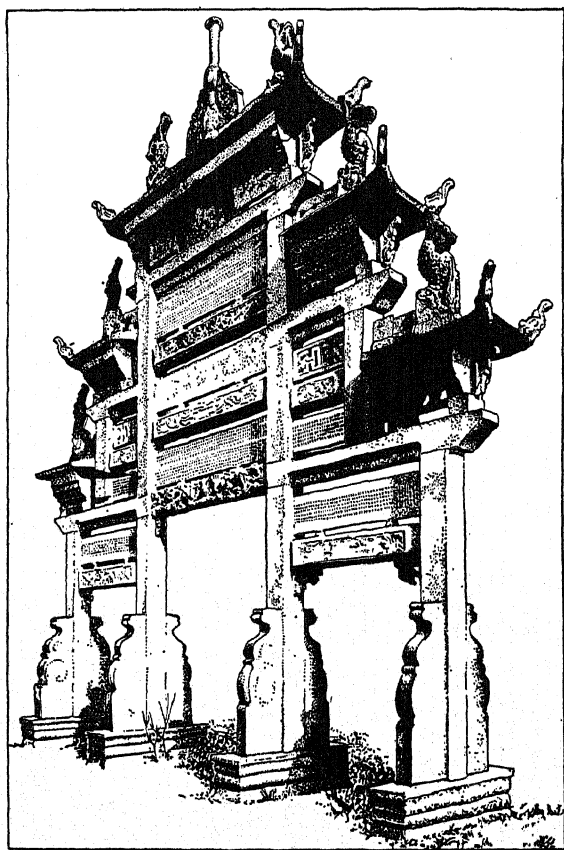
Several methods of treatment have been described—rectal feeding, duodenal feeding and starvation periods of a few days. A period of rest in bed is advisable at first. The underlying principle is frequent feedings of a bland comminuted easily assimilated diet with addition later of other foods. Alkalis are used by some physicians and not by others. Spices, condiments, pickles, cucumbers and various raw vegetables and fruits are omitted for a long time. Recurrences are frequent with indiscretions in diet. Indolent ulcers often require some form of surgical treatment, as excision of the ulcer bearing area or some form of short circuiting operation. Surgical treatment is required for perforation and obstruction and generally in the case of repeated hemorrhage. L. B.

GASTRITIS, inflammation of the lining of the stomach, due to improper diet, decomposed food, excessive use of alcohol, infection or poisonous substances. In *acute gastritis* the symptoms are those of indigestion: nausea, gas formation, discomfort and vomiting. There may be diarrhea or constipation. The usual treatment is administration of mild purgatives, bicarbonate of soda and bismuth, and refraining from food. The *suppurative form* is due to infection of the stomach lining, with resulting abscess or tumor formation. This form is serious and peritonitis may follow. The *toxic form* is due to swallowing of poisonous substances and is accompanied by hemorrhage and a breakdown of the stomach tissues which appear as a brownish black vomitus. There is pain in the abdomen and distention, and convulsions or collapse may follow. The treatment is for poisoning (*see* ANTIDOTES), washing out of the stomach, and sedatives. Gastritis often accompanies infectious diseases and may be caused by parasites. *See also* DYSPEPSIA. *Chronic gastritis* is due to dietetic and constitutional disorders and to local causes such as ulcers. It calls for dietetic and symptomatic treatment, and may last an indefinite period of time.

GAS WARFARE. *See* CHEMICAL WARFARE.

GATE. In most countries of the world, the outer entrance, or gate, to city, fortress, palace and private dwelling has naturally been of great consequence in building, through the ages. Until comparatively re-

cent centuries, the gate was, primarily, the point of concentrated defense against possible attack. It was therefore, in its structure, both strong and complicated. References to the Assyrian fortified gate of Khorsabad are found in the Bible. The famous Greek Gate of the Lions, at Mycenae, is approached by a long, easily defended passageway. Roman gates, with separate passages for foot marchers and wagons, with portcullis and flanking bastions, can be studied at Pompeii, at Trèves in Germany, Autun in France, and elsewhere. The type of medieval gateway, with its developed complications, is to be seen in the Cité de Carcassonne (*see* CARCASSONNE), during the Middle Ages an exceedingly important border fortress. With the coming of more peaceful times the gatehouse, especially that of the private homestead, lost its military significance and was retained as an architectural feature. This can be seen to particular advantage in the Elizabethan manor in England. Here the gatehouse was joined to the main building by a wall, and was itself often very commodious as a dwelling; in later times the gatehouse became a mere lodge. Medieval city gates are found in many places on the continent



CHINESE MEMORIAL GATE AT LILINGHSIEN, PROVINCE OF HUNAN

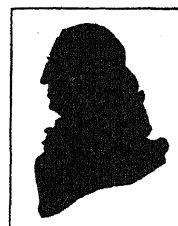
of Europe, with towers and gatehouses which made them effective as little forts. The celebrated city gates of Verona are fine examples of Italian Renaissance architecture. Modern gates, ornamental iron

work between masonry piles, are often of distinctive and beautiful design.

In the Orient, the city gate was historically, and in some Mohammedan countries still is, an important center of public life: the seat of justice, the market, the meeting-place. In Spain the Moors have left names which attest this usage, as *The Gate of Justice*, and *The Gate of Pardon*. The imperial government of Turkey, abolished in 1922, was known as the *Sublime Porte*, a literal translation of the High Gate of Constantinople. Among the Greeks and Romans, gates were built as memorials, and monuments to military triumph, and were often magnificent.

Symbolically, the gate has a place of significance in almost all literatures, and in the legends of almost all peoples.

GATES, HORATIO (1728-1806), American general, was born in Essex, England, in 1728. He came to America as a captain of infantry in 1755, and took part in Gen. Braddock's campaign against the French. In 1760 he was assigned to Fort Pitt, and in 1762 participated in the capture of Martinique under Gen. Monckton. He retired to a farm in Virginia until the revolt of the Colonies from England. He was then commissioned an adjutant-general in the Colonial Army and in 1777, by skilful intrigue, managed to supersede Schuyler in command of the Army of the North. His victory over Burgoyne at SARATOGA brought him high honor, and he immediately attempted to supersede Washington as Commander-in-chief by means of the CONWAY CABAL. This failed, but in 1780 Congress gave him command of the Army of the South. His defeat by Cornwallis at CAMDEN in 1780 cast suspicion upon his courage and military ability, although he was acquitted in 1782 of the charges made against him. Following his trial he returned to his Virginia farm, staying there until 1790. In that year he freed the slaves on his land and went to New York City, where he remained until his death 16 years later.



SILHOUETTE OF
GEN. HORATIO
GATES BY MAJOR
JOHN ANDRÉ

GATES, THOMAS SOVEREIGN (1873-), American financier and educator, was born at Germantown, Pa., Mar. 21, 1873. He graduated from the University of Pennsylvania in 1893, and was admitted to the Pennsylvania bar in 1896. Gates became a successful banker and held many important financial positions, among them the presidency of the Philadelphia Trust Co., and partnerships in Drexel & Co., and of J. P. Morgan & Co. He deserted finance in 1930 to become president of the University of Pennsylvania.

GATES, a term applied in hydraulic engineering to movable barriers for controlling the flow of water into conduits, through reaction water turbines (*see* TURBINES, WATER) and over masonry DAMS. Their structural design classified them as flat, radial and cylinder. Depending upon their manner of move-

ment, flat gates are of sliding, rolling and pivot types; radial gates of *Tainter* and drum types; and cylinder gates of rolling and lift types. Rolling flat gates are further subdivided into fixed-roller, caterpillar-roller and live-roller or *Stoney* gates.

Flat gates consist of a flat, nearly water-tight face plate supported by horizontal beams which are attached to vertical girders provided with bearing strips, similar strips being embedded in the supporting masonry structure or pier. These strips form the sliding surfaces of sliding gates. *Stoney* gates roll on independent roller trains placed between the bearing strips on the gate and those on the pier.

The face plate of a *Tainter* gate is a portion of a horizontal cylinder with its convex face upstream and supported by a system of beams, girders and trusses transmitting the water pressure through two bearings located on the axis of the cylinder to steel pins projecting from supporting piers, the entire gate rotating about these pins as it moves.

Cylinder gates are steel cylinders strengthened by internal beams, girders and trusses. The rolling type is a closed-end, horizontal-axis cylinder moving on inclined tracks on the piers. The lift type is an open-end, vertical-axis cylinder moving vertically to provide an annular passageway controlling the flow into a turbine or into a vertical cylindrical conduit. F. K.

BIBLIOGRAPHY.—W. P. Creager and others, *Hydro-Electric Handbook*, 1927.

GATESHEAD, a town of county Durham, England, on the right bank of the Tyne, opposite Newcastle with which it is connected by three bridges. The principal manufactures are girders, anchors, chain cables, engines, rope and glass; there are ship-building yards and brass, copper and iron foundries. The famous Newcastle grindstone is quarried in the vicinity. The church of St. Mary, an ancient edifice which was partly destroyed by fire in 1854, and afterwards restored, was the scene of the murder of Bishop Walcher in 1080. Pop. (of county borough) 1921, 125,142; 1931, 122,379.

GATLING, RICHARD JORDAN (1818-1903), American inventor, was born in Hertford Co., N.C., Sept. 12, 1818. Although he was a graduate of the Ohio Medical College he never practiced medicine. As a boy he assisted his father in perfecting agricultural implements, and in 1850 he invented a hemp-breaking machine and in 1857 a steam plow. When the Civil War broke out he began experimenting with firearms, and in 1886 invented the revolving machine gun known by his name and adopted by many countries. Congress voted him \$40,000 to experiment on a new method of casting cannon. He died in New York City Feb. 27, 1903.

GATTI-CASAZZA, GIULIO (1869-), Italian opera manager, was born at Udine, Feb. 5, 1869. He intended to become a naval engineer, but in 1892 succeeded his father as director of the Ferrera Municipal Theatre. During 1898-1908 he was director of La Scala, Milan, and in 1908 he succeeded Conried at the Metropolitan Opera, New York. His noteworthy

New York productions include *Boris Godounov*, *Der Rosenkavalier*, and *Coq d'Or*. In 1930 he married Rosina Galli, premiere danseuse of the Metropolitan Opera ballet.

GATUN DAM, located on the Chagres River, Panama Canal Zone, is an earth dam that creates a lake forming part of the Panama Canal waterway. It also acts as a storage reservoir for the supply of water for the Canal, and is notable for its great thickness of 2019 feet at the base and its volume of 22,958,000 cubic yards—the largest of any dam in the world. It is 110 feet high above foundation level, 100 feet wide on top and 7700 feet long. Its massive proportions were adopted in order to amply insure the safety of the Canal. The spillway is a curved, concrete structure adjoining the earth dam.

GAUDIER-BRZESKA, HENRI (1891-1915), French sculptor, was born near Orleans, France, Oct. 4, 1891, as Henri Gaudier. He studied art in Paris, then moved to London where he added the name of Brzeska to his own. His drawings show great ability; but sculpture was his best medium. His sculptures include *Seated Figure*, *Torso*, in the Victoria and Albert Museum, London; *Fawn*, *Mother and Child*, *Dancer and Imp*, head of Brodzky, and *The Fallen Workman*. He was killed while serving with the French army at Neuville St. Vasst, June 5, 1915.

GAUGUIN, PAUL (1848-1903), French Post-Impressionist painter, sculptor and author, was born at Paris, June 7, 1848. As a youth he went to sea and later gave up a successful career as a banker to study painting. In 1881 he left his family and went to Martinique, later to Pont Aven, in Brittany, where he founded a school of painting known as Synthetism, and finally to the South Sea Islands. Here, living like a native, he painted the native men and women in their exotic settings, producing decorative canvases which vibrate with the heat of tropical sunlight and the richness of tropical color. In his book *Noa Noa*, published 1897, Gauguin tells of his life in Tahiti, where he died, May 9, 1903. Gauguin stands at the forefront of Post-Impressionist painters, ranking with Cézanne and Van Gogh.

GAUL, the Roman *Gallia*, a region of ancient Europe subject to Rome comprising Transalpine Gaul, or France and Belgium, together with parts of Germany, Switzerland and Holland, and Cisalpine Gaul, or northern Italy. In common, if somewhat erroneous usage, Gaul is France. See FRANCE, HISTORY OF. Caesar and other classical historians identified Gaul with the lands of the Celtic tribes. *Gallia Cisalpina*, or *Hither Gaul*, lay, roughly speaking, from Rome to the southern side of the Alps, *Gallia Transalpina*, or *Farther Gaul*, occupied all the territory north and northwest of the Alps, and, as divided by Augustus, comprised the divisions of *Narbonensis*, *Aquitania*, *Lugdunensis* and *Belgica*, or, what is today central Europe. Cisalpine Gaul was gradually drawn under Roman power during the first and second Punic Wars, and, by 201-191 B.C., was a

part of the Empire; by 43 B.C. it was made a Roman province. Transalpine Gaul was first settled at the end of the 2nd century B.C., and Julius Caesar conquered the territory from 58 to 51 B.C. In Caesar's time, according to the historian Freeman, Transalpine Gaul was divided into Aquitaine, Celtic Gaul and Belgic Gaul. France rose in Celtic Gaul. Aquitaine, reaching to the valley of the Garonne, was Iberian in character, resembling the peoples of the later Spain. German tribes dwelt in Belgic Gaul. In the 4th century Gaul was divided into 17 provinces. Cispadane Gaul was the term for Cisalpine Gaul south of the River Po; Transpadane Gaul of Cisalpine Gaul north of the Po. In old English Gaul was sometimes a synonym for Wales as well as for France.

GAULISH, an extinct CELTIC language formerly spoken throughout the area of modern France and Belgium, in northern Italy, in portions of the Iberian Peninsula and, through migrations, in southeastern Europe and in Galatia in Asia Minor. Belonging to the *p*-group of Celtic, it was closely akin to WELSH, CORNISH and BRETON, and it survived as a vernacular until at least the 5th century. Its only remains are numerous glosses and personal or local names, a few sentences recorded by Latin writers, and over 100 inscriptions, mostly very short and often obscure, the only long text being the difficult *Calendar of Coligny*. The inflexion of the noun is fairly clear; of the verb only scanty fragments remain.

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GAUR, a wild ox (*Bibos gaurus*) of India and the Malay Peninsula; the "bison" of British sportsmen. It is the largest of the oriental wild oxen; the bulls measure 6 ft. tall at the elevated shoulders and are shining black in color with white "stockings." The thick horns extend outward from the convex summit of the skull, then turn upward. This forest-ox, which prefers the deepest and most hilly jungle, is regarded as dangerous game, and has never been domesticated.

GAUSS. See MAGNETIC UNITS.

GAUSSIAN LOGARITHMS, a system of logarithms first published by K. F. Gauss in 1812, by which the logarithm of the sum of two numbers can be found from the logarithms of the numbers alone. That is, the table of Gaussian logarithms showed how to find $\log(a+b)$ from $\log a$ and $\log b$. Common logarithms to the base 10 are used in connection with multiplication, division, powers and roots. They are not adapted to general addition, as in finding $\log(a+b)$ from $\log a$ and $\log b$. In 1803 an Italian, Leonelli, suggested a way of overcoming this difficulty, and this resulted in a set of tables published by KARL GAUSS in 1812. By the aid of these tables it is possible to find $\log(a+b)$, by adding to $\log b$ a number given in the tables, and similarly for $\log(a-b)$. See LOGARITHMS.

GAUTAMA or **GOTAMA** (563-483 B.C.), the most notable of the sons of India, was born in Kapilavasthu, 100 miles northward from Benares. The site of his birth was discovered in 1896. He was the

elder son of a petty raja in the republican kingdom of Kosala (modern Oudh), and was reared, as the heir of a martial throne, in princely fashion. As a warrior's son he had no concern for books, and spent little time in reflection. At the age of 19 he was married to Yasodhara, a princess from a neighboring state, who 10 years afterwards, became the mother of his only child, the boy Rahula. During the decade a change took place within him—or was it that he began to look forward to the normal third stage of life, that of the recluse? He began to take thought of life, his eyes were opened to the futility of his own ways, he reflected upon the weaknesses of the flesh and the misery of the world about him. It distressed him to observe that he and all mankind were liable to old age, disease and death, and he became a seeker for a way of escape.

For six years, from the age of 29 when he left his home and family to take up the wanderer's life, he took account of various ways, chiefly that of the strict ascetic. Two qualities he possessed in unusual measure, compassion and intellectual skill, and these determined most largely the outcome of his quest. Sitting one time, at the age of 35, under a fig-tree (the Bo-tree, or "tree of enlightenment") at Gaya, (near Patna) worn thin and weak by austerities, he came to realize the value of *another* way (see BUDDHISM), known as the Middle Way, or Eight-fold Path, as the means of release from the world of suffering. Thereafter, until his death, he gave himself up to analyzing and expounding this Way, in all parts of the section known to-day as Bihar (*vihara*, "monasteries"), the "holy land" of Buddhism. He won many disciples from "Hinduism," and when his end approached, there were 500 "brothers" (*bhikkhus*, who had "renounced" the world) about him, to whom he gave his last message, "Decay is inherent in all component things. Work out your own salvation with diligence!" Siddhattha Gotama (as it is in his own Pali tongue) had become The Buddha, "The Enlightened One," and The Tathagatha, or "The Completed One," had won many notable disciples as well as hosts of converts, and had laid the foundations of a world-religion. J. C. A.

See K. J. Saunders, *Gotama Buddha*, 1920; H. Oldenberg, *Buddha*, 1928.

GAUTHIER, CHARLES HUGH (1843-1922), Canadian prelate, was born in Alexandria, Ont., Nov. 3, 1843. He was educated at Regiopolis College, Kingston, and ordained to the Roman Catholic priesthood in 1867. Thereafter he served as priest at Gananoque, Westport, Williamstown, Glen Nevis and Brockville, and for a time was professor of rhetoric at Regiopolis College. In 1898 he was elevated to the archbishopric of Kingston, where he remained until 1910. That year he became archbishop of Ottawa and served as such until his death there, Jan. 19, 1922.

GAUTIER, THEOPHILE (1811-72), French novelist, critic and poet, was born at Tarbes, Aug. 31, 1811. First studying to be a painter, he soon

devoted himself to writing, and in his first important poem, *Albertus*, 1830, showed individual genius. A finer poetic work, *La Comédie de la Mort*, followed in 1832, then several further volumes of verse, culminating in *Émaux et camées*, 1856. In 1835 Gautier's famous novel, *Mademoiselle de Maupin*, was published, and after that other novels and short stories. He also did much journalistic work, particularly dramatic, art and literary criticism, and later wrote books of travel, including *Voyage en Espagne*, 1845, and *Constantinople*, 1854. At first an extravagant young Romantic, Gautier was one of the earliest writers to preach and practice the doctrine of "art for art's sake." He took no interest in social or moral questions, and remained purely the *littérateur*, with a distinguished style and a large and widely varied output. He died at Neuilly, Dec. 23, 1872.

GAVIAL or **GHARIAL**, a species of crocodile recognized by its extremely long and narrow snout and large number of teeth, 27 to 29 on each side of the upper jaw. This high tooth count distinguishes the gavial from all other living crocodilians, no other having more than 21 teeth on one side in the upper jaw. The gavial (*Gavialis gangeticus*) is the sole member of its genus, but another long-snouted species, the Malayan or false gavial, is found on Borneo and other East Indian islands. It has, however, only 20 to 21 teeth in the upper jaw. Thoroughly adapted to an aquatic life, the true gavial is unusual in subsisting largely upon fish which it readily catches with its long snout. The eggs, 40 or more in number, are buried in sand-banks, newly hatched examples measuring 14 to 16 in. in length. It is known from the Indus and Ganges, and other river systems of India and Burma. C. H. P.

GAVOTTE, name for an old French dance in duple meter and lively tempo. It was later adopted as an interpolated movement in the *SURTÉ*. It is hardly to be distinguished from the *BOURRÉE*, save that it generally begins on the third rather than on the fourth beat of the measure. A trio-section, in the form of a musette fashioned over a drone bass, is not uncommon.

GAWAIN, SIR, in the *ARTHURIAN LEGENDS*, a knight of the Round Table and King Arthur's cousin, surnamed "the Courteous." In the earlier romances he is brave and wise, but in Tennyson's *Idylls of the King*, he is represented as light, cynical and faithless.

GAY, JOHN (1685-1732), English poet and dramatist, was born in Barnstaple in Sept. 1685. In his youth he was apprenticed to a silk merchant but was released because of his inaptitude for business. Much interested in poetry, he went to London where he was soon received into the circle of famous wits and literary men, enjoyed the patronage of members of the nobility and wrote many dramas and volumes of poetry. Gay won success and enduring fame with his lyric drama, *The Beggars' Opera*, produced in 1728, which after two centuries was revived with long runs in London and New York. Gay's *Fables* have gone into many editions and have been translated into several languages. He died in London in 1732.

GAYA, a city and district in the Patna division of Behar and Orissa, British India. The city, served by the Grand Chord Line of the East Indian Railway, is noted for its associations with Buddha and as a place of Hindu pilgrimage. Among its beautiful shrines and temples is the Vishnupad Temple, built by Ahalya Bai in 1787. The district of Gaya, bounded on the south by the Mahabar Hills, is chiefly a plain watered by the rivers Punpun, Phlugu, Son, Nilajan and Mohana. Shellac, mica and carpets are the major industrial products. Area 4,714 sq. mi. Pop. 1921, city, 67,562; district, 2,152,930; 1931, 2,386,323.

GAYAL, an ox (*Bibos frontalis*) of northeastern India, called also mithan. It is of moderate size, is black with lower legs white; and has thick, round black horns, curving slightly upward from the sides of a flat-crested skull. It exists, so far as known, only as kept in a semi-domestic condition by native hill-tribes for its beef, and it is not an object of sport.

GAY-LUSSAC, JOSEPH LOUIS (1778-1850), French physicist and chemist, was born at Saint-Léonard, Dec. 6, 1778. In 1808 he was appointed professor of physics at the Sorbonne and in 1809 of chemistry at the École Polytechnique. He investigated problems relating to the physical and chemical nature of gases and, with John Dalton, established that the volume of a gas varies proportionally with the temperature. He also demonstrated that the volume of a gaseous product of the chemical union of two gases bears a simple numerical relation with the original volumes of the combining gases. Additional contributions by Gay-Lussac to chemistry advanced chiefly the technique of chemical analysis. He made two balloon ascensions, in 1804, to make magnetic observations above the earth, and concluded from these experiments that terrestrial magnetism is constant at an altitude of at least 7,000 meters. He died at Paris, May 9, 1850.

GAZA, a city of Palestine, located in the south, three miles from the shore, and forming a natural gate from Egypt into Palestine by way of the coast. Cloth weaving constitutes the chief occupation of the native Arabs. Grain is exported from the harbor. Gaza is mentioned in the Bible. The Moslems occupied the city in 634 and it was seized by the British in Nov. 1917. Pop. 1922, 17,480; 1931, 17,069.

GAZA, BATTLE OF. The first prominent Battle of Gaza occurred in Oct. 332 B.C. when ALEXANDER THE GREAT besieged the city of Gaza, lying at the southern end of Canaan, near the Mediterranean. He was able to break through the strongly fortified walls with his powerful war machines, finally taking the city by storm. In 312 B.C., the Macedonians were routed from Gaza by the Syrians and Egyptians. During the British campaign against the Turkish forces in Palestine in the WORLD WAR, Gaza's strategic location again became an important point.

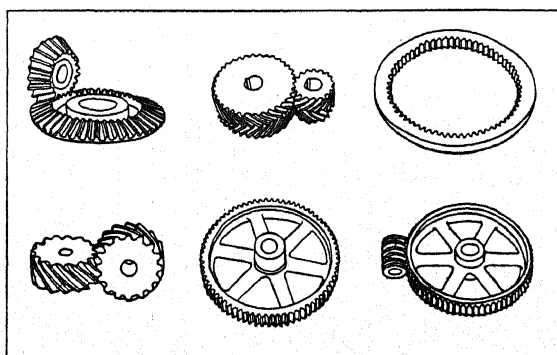
GAZELLE, one of a group of small desert antelopes of many African and Asiatic species. They form the subject of much oriental poetry and legend, and are

frequently kept as pets, prized for their graceful, gentle ways. They abound in the oases of Egypt, Arabia and Syria, and related species, under various names, inhabit Persia and Mongolia. India has a famous example in the miscalled blackbuck, which has a semi-sacred character. The best known one is the dorcas gazelle of the Sahara Desert.

GDYNIA, the principal Polish port on the Baltic Sea and one of the chief Baltic ports, situated on the Bay of Danzig. As late as 1920 it was an unknown fishing village. The construction of the port was begun in 1924 and by 1930 the annual clearance was 2,238 vessels with a tonnage of 2,029,822 tons and 24,169 passengers, not counting coastal traffic. Gdynia is also a popular seaside resort, having a sandy beach and a charming district of villas situated on the Kamienna Gora. The large and modern railway station was erected in 1930. About 5,000 people visit Gdynia annually. Pop. 1931, 30,210.

GEAR CUTTING MACHINES, machines for cutting gear teeth, are of two types: 1. Machines using a rotary cutter; and 2. Reciprocating machines. Machines of the rotary type are developments of the MILLING MACHINE and use either formed cutters or a continuous type of cutter known as a "hob." (See HOBGING MACHINES.) Reciprocating gear cutters are either called gear planers or gear shapers. They use either single-tooth formed cutting tools or cutters resembling gears. In the latter, each tooth cuts the gear blank and it and the cutter roll together between the cutting strokes. See also GEARS; MACHINE TOOLS.

GEARS, toothed wheels to transmit positive motion between shafts or between a revolving shaft and a plane surface tangent to it. Formerly gears were frequently called cog wheels although this usually referred to large gears having inserted wooden teeth. Most gears are round but there are also many of special shapes, as, e.g., elliptical and heart-shaped gears designed to transmit a continuous but irregular motion, usually between parallel shafts; they are also



TYPES OF GEARS

From left to right—bevel, herring-bone, internal; second row—helical, spur gear, and a worm gear

made beveled, or with angular faces for shafts set at an angle with each other. The various types of gears in common use are shown in the accompanying figure.

Gear teeth with few exceptions are now cut with

an involute curve on the contact faces as it has been found that this gives the smoothest action and has the best wearing qualities. Teeth are formed by cutters shaped to the proper curve (see GEAR CUTTING MACHINES) and are generated by revolving together the cutter, and the blank wheel that is to become a gear, in such a way that the teeth are properly cut.

The important measurement in a gear is not the outside diameter but the "pitch" diameter, as this determines the relative velocity of the two gears. This fact is perhaps best understood by considering two plain discs rolling together. If there is no slip, one will drive the other at a speed depending on their relative diameters. If, to prevent slippage, we build up teeth on each disc and cut corresponding hollows between these teeth, we have two gears which drive at the velocity of the pitch line, or disc diameter, and not that of the outside of the teeth. In some cases we increase the distance that the teeth of one gear project beyond the pitch line, and decrease the length of the teeth of the mating gear, but the relative velocity depends entirely on the location of the pitch line rather than on the outside diameters.

Tooth dimensions are measured with relation to the pitch line, and tooth sizes are given in terms of the number of teeth per inch of pitch diameter. The portion of the tooth beyond the pitch line is called the addendum and that below the pitch line the dedendum, these being shown in the accompanying

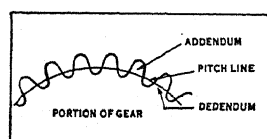


figure. Gear teeth are made with long and short addendum or dedendum, and the whole length of the tooth is varied to suit the ideas of the designer,

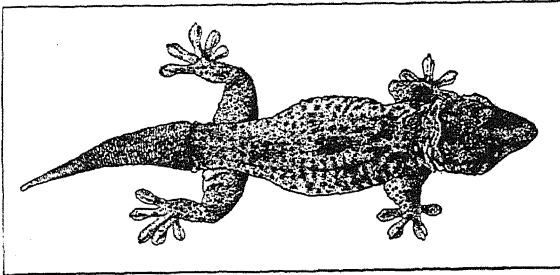
some using a short tooth, called a "stub" tooth, and some advocating a longer tooth known as a "spring" tooth, which is designed to spring slightly under load and so distribute the load among several teeth. Various pressure angles are also advised for special cases, the standards being $14\frac{1}{2}^\circ$ and 20° .

To secure more quiet operation, teeth are frequently cut at an angle across the face of a gear. As these teeth assume the form of a helix the gears are called helical gears and sometimes are erroneously referred to as spiral and skew gears. Helical gears which are made double with the angles of the teeth in opposite directions are called herring-bone gears. They are usually made in one piece but sometimes are formed of two opposite angle gears fastened together, usually by RIVETS or BOLTS. The form of bevel gear now used in the final drive of automobiles is known as the spiral bevel. Worm gearing, in which a screw or "worm" drives a specially cut gear, or "worm wheel," is also used in some motor vehicle drives, in elevators and other machinery.

Internal gears have the teeth cut on the inside of a ring. Unless of large size they can be cut only by the shaping process (see SHAPERS). They are used to some extent in automobile transmissions and for special purposes.

Differential gearing is a special arrangement of various gearing either for equalizing power distribution or for counting or securing a fixed variation in speed between parts of a mechanism. F. H. C.

GECKO, any lizard of the large and varied family *Geckonidae*. These saurians, widely distributed throughout the warmer climates, are characterized by their soft skin, granular scales, lack of movable eyelids and specialized adhesive toes. Their classifica-



WHITE-SPOTTED GECKO

tion is based on the structure of the toes and it is this structure that allows many of them to cling to smooth or rough vertical surfaces. They are harmless and insectivorous and reproduce by laying eggs. Geckoes often frequent human dwellings and consequently many strange beliefs have developed around them. They are found in diverse habitats ranging from tropical forests to open deserts. Some species exhibit remarkable protective coloration, their bodies resembling in pattern the bark of trees.

GED, WILLIAM (1690-1749), invented in 1725 a process by which he made from type, stereotyped plates. Both the printing trade and the compositors of his home city of Edinburgh were unwilling to take up his invention. He went into partnership with a London stationer, procured contracts for printing but was not successful financially and failed to exploit his patent. He died in poverty, Oct. 19, 1749.

GEDDES, SIR AUCLAND CAMPBELL (1879-), British physician and diplomat, born at Edinburgh, June 21, 1879. Studying medicine at Edinburgh, he was for a time at a London hospital and then continued in Germany. He has been a professor of anatomy in Edinburgh, Dublin and at McGill University, Montreal. He served in the South African and in the World War. A member of parliament (1917), after the Armistice he held important posts and went to Washington as ambassador (1920-23).

GEELONG, a seaport city of Victoria, Australia, situated on an arm of Corio Bay, about 45 mi. southwest of Melbourne. The city has an excellent harbor and is important industrially, being particularly noted for the superior quality of its woolen cloths and its large exportations of wool. It also manufactures salt, leather and flour. Est. pop. 1929, 43,580.

GEGENBAUER, KARL (1826-1903), German anatomist, was born at Würzburg, Aug. 21, 1826. From 1853 to 1873 he was professor at Jena and

thereafter until 1901 at Heidelberg. He early applied evolutionary concepts to anatomy and worked on the theory that the principles found applicable to invertebrate development could be adapted to vertebrate development. This, coupled with his constant search for homology and analogy in organs and the drawing upon embryological development for light upon the evolutionary changes, made Gegenbauer the principal founder of modern comparative anatomy. He died at Heidelberg, June 14, 1903.

GEGENSCHNITT, or counter glow, a faint patch of light sometimes seen in the sky, exactly opposite the sun, and part of the ZODIACAL LIGHT.

GEIGER, ABRAHAM (1810-74), one of the most eminent leaders and thinkers of the Reform Jewish movement in Germany, was born at Frankfurt-on-Main in 1810. As a rabbi he served congregations in Breslau, Frankfurt and Berlin. As early as 1832 he received a prize from the University of Bonn for his work entitled *What Mohammed Adopted From Judaism*. In 1854 he published a Reform *Israelite Prayer-Book*, after years spent in championing the moderate Reform movement in Judaism. He played a prominent rôle in the three important and historic Reform conventions at Brunswick in 1844, Frankfurt in 1845, and Breslau in 1846. In the course of his manifold efforts in behalf of Reform Judaism Geiger came into conflict at various times with Salomon Tiktin, Samson Raphael Hirsch, and Zacharias Frankel. He died at Berlin in 1874.

In his early youth Geiger devoted himself to classical, philosophical, historical and Arabic studies. In his later years he pursued work in Bible, Mishna, apologetical literature, and the Jewish philosophical and poetical writings of the Middle Ages. In his own works, of which the most important were *Lehr- und Lesebuch zur Sprache der Mischna*, 1845; *Paraschandatha, die Nordfranzösische Exegetenschule*, 1855; and *Urschrift und Übersetzungen der Bibel in ihrer Abhängigkeit von der Inneren Entwicklung des Judentums*, 1857, he realized the practical importance of science and historical criticism for theology. He considered the teachings of the prophets the true essence of Judaism, i.e. the belief in the one God, and the practice of universal philanthropy and altruism. He believed only in the universal aspect of Messianism, not in its national or personal aspect, and recognized the importance of the revelation and of certain fundamental doctrines, while not laying much stress on the ceremonial law. His practical theology and his writings were of tremendous import in shaping the course of the development of the Reform movement in Judaism both in Germany and in the United States. A. SH.

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GEIJER, ERIK GUSTAF (1783-1847), Swedish historian and poet, born at Ransäter, Vermland, Jan. 12, 1783. He was educated at Upsala and afterwards became instructor in history there. He was one of the

founders of the Gothic Association and of its organ, *Iduna*, to which he contributed some of his early poems. The aim of the Gothic Association was to create a national Romantic movement based on the distinctive culture of the old North. Together with Arvid August Afzelius, the poet and antiquary, Geijer made a collection of *Swedish Folk Ballads of the Past*. His own poems, comparatively few in number, took their themes from Northern antiquity. The most important of his historical works are *Records of the Kingdom of Sweden* and *History of the Swedish People*. He died at Stockholm, Apr. 23, 1847.

GEISSLER EFFECT. See ELECTRIC DISCHARGE.

GELA, a city of ancient Sicily on the southern coast, situated on the Gela River. The town was founded by Rhodians and Cretans in 690 B.C. Becoming rich and powerful, it founded Agrigentum in 582. Gela came under the rule of tyrants, among them Hippocrates, Hieron and Gelon, the latter of whom in 280 B.C. moved half its inhabitants to Syracuse, his capital. After this the prosperity of Gela declined. The poet Aeschylus died here.

GELADA (*Theropithecus gelada*), a baboon inhabiting the high mountains of southern Abyssinia. It differs from all other baboons by the nostrils being situated not at the tip of the muzzle but at a space from the tip. With a heavy mane about head, neck and forequarters and a tail of medium length tufted at the end, it resembles a dark-brown shaggy dog that has been recently shorn. On the chest are two brightly colored triangular bare spots separated by a line of hair. Geladas, like the true baboons, walk on all fours and keep to the ground. They are about 2 ft. long, with powerful sturdy bodies. Their faces are black and nude, and they have black callosities on their buttocks. Their food consists of seeds, roots and tubers; they sometimes raid fruit plantations.

GELASIUS I, ST. (?-496) pope from 492 to 496 and successor of Felix III, was born in Africa. The date of his birth is not known. He is supposed to have written parts of the liturgical compilation entitled *Gelasian Sacramentary*, a book of sacramental and Mass rites. Some of his letters and a treatise on the Eutychians and Nestorians are extant. He was a staunch supporter of Church discipline, and was canonized on his death in 496.

GELATIN is made from clean, fresh bone, skin, sinews, and connective tissues of meat producing animals. In the case of bone, both the mineral matter and the fat must be removed by suitable solvents. The preparation is somewhat simpler when skin or sinews are used. Collagen is the material which is converted into gelatin on boiling or heating with water. The jelly solutions are concentrated, dried and ground or pulverized and then served as the raw materials for the various jelly powders sold as such or colored and flavored ready for use as a dessert. Gelatin adds considerably to the value of the cereal proteins and is an important adjunct to milk in the feeding of infants and invalids. Gelatin also has a number of industrial uses. See also COLLAGEN.

GELLÉE, CLAUDE. See CLAUDE LORRAIN.

GELLERT, CHRISTIAN FÜRCHTEGOTT (1715-69), German poet, fable-writer and theologian, was born in Hainichen, Saxony, July 4, 1715. He studied theology and became Professor of Philosophy at Leipzig, 1751-69. His masterpiece is probably a famous series of *Fables and Aphorisms*, 1746-48; comprising didactic and mildly satirical studies of contemporary foibles. He also wrote several comedies, a novel imitating Samuel Richardson and a group of *Spiritual Songs*.

A representative of his century in his rationalism and sentimentalism, Gellert died at Leipzig, Dec. 13, 1769.

GELLIUS, AULUS (c. 130-180), Latin writer, was born at Rome, about 130. He lived for some years in Athens, where he studied philosophy. His *Noctes Atticee* is a collection of impressions, quotations and assorted facts; it gives much valuable information about the times. Gellius later returned to Rome and studied law. He died in Rome in 180.

GELON (died in 478 B.C.), tyrant of Gela and Syracuse. One of a long series of rulers in Syracuse who defended the Greek portion of Sicily from subjection to the Carthaginians. Refusing to aid Greece when invaded by the Persians under XERXES, he decisively defeated the Carthaginians at Himera in Sicily in the very year, 480 B.C., that Xerxes' fleet was overwhelmed at Salamis. Gelon was an able and benevolent despot.

GELS. When colloidal particles (see COLLOIDS AND COLLOIDAL STATE) unite into practically non-motile larger groups, they may be said to form a gel. If the original colloidal dispersion has been very dilute, the aggregates float about as flocs, which sink or rise to the surface, depending on their specific gravity. If the colloidal dispersion is sufficiently concentrated, or if the flocs collect or are collected together and form a matted mass, they then constitute a more or less solid gel. Any gel which resembles that made by a chilled solution of GELATINE or GLUE, may, by similitude, be termed a "jelly." Gels are classed as reversible or irreversible, depending on whether their particles can be again brought into free colloidal dispersion by heat, agitation, peptizing agents, etc. See also EMULSIONS; SOLS. J. A.

GELSENKIRCHEN, a German city in Rhenish Westphalia situated about 20 mi. west of Dortmund on the Rhine-Herne canal, now a part of the municipality of Gelsenkirchen-Buer. The city grew very rapidly from 30,000 inhabitants in 1890 to 170,000 in 1910, progressing along with Essen, Buer and other neighboring towns. It is an industrial city with extensive coal mines. It has 263 coal pits, yielding about 10% of the entire coal mined in the Ruhr district and 8% of the pit coal mined in Germany. It has a modern central coke-burning plant and 22 iron and steel works. Its large industries number 38, while the smaller concerns total 8,500. Gelsenkirchen was first mentioned 1150. It has been repeatedly enlarged by annexing other places and was united with Buer

and Horst, Apr. 1, 1928. Pop. Gelsenkirchen-Buer 1925, 330,186.

GEM CUTTING falls into two classes: (1) the ancient gem engraving, and (2) the treatment which prepares gems for use in jewelry. Gem engraving is a very old art, many engraved seals, or intaglios, having been found which date from ancient Babylonian times; these are the oldest engraved gems. The Babylonian tradition was adopted by the Assyrians, who in turn passed it on to the Persians and other peoples. The engraved Egyptian scarab is well known. The earliest Greek work goes back to about 3000 B.C., and that of 2000 B.C. was extremely fine, using interesting animal forms. In general, Greek work shows great beauty, delicacy and variety; it was the Greeks, too, who made the first cameos, gems in which the design was raised in relief, instead of being cut out in the stone. The Romans also engraved gems beautifully, but under the later Empire the art declined along with sculpture. During the Renaissance, under the patronage of Lorenzo de Medici, the art was revived in Italy. In the 16th century it flourished in Germany and France. After another period of decline, gem engraving was brought to a high point of workmanship in the 18th and 19th centuries.

In cutting gems for use as ornamentation in jewelry, ancient peoples did not facet the stones as is done to-day. Until the 14th century almost all stones were cut either *en cabochon*, with smooth rounded surfaces, as opals and carbuncles still are, or as beads, with perforations. In the 10th and 11th centuries rock crystal was shaped in a way that suggests a transition to faceting; but the present fashion of cutting almost all gems with plane surfaces is entirely modern. The craft of gem cutting in its modern form was developed from the Renaissance onward, and was greatly perfected during the 17th and 18th centuries. The Oriental method of cutting gems has been, and still is, to preserve as much of the stone as possible, following its natural lines; stones are consequently produced in a great variety of shapes. The occidental gem cutter sacrifices a large part of his gem to the regularity of his faceting, but he gains not only symmetry but great brilliance through refraction. In all gem cutting the greatest effort is made to enhance the effect of the stone's best color. The beauty, and thus the value, of a gem depends upon its hardness, brilliance and tone, this last meaning the clarity and absence of tint in an uncolored stone, and the depth and richness of the color if it has color. In ancient days superstition attached an extrinsic value as talismans to many gems. See also **CAMEO**; **INTAGLIO**.

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GEMINI, in Roman mythology, the name given to **CASTOR** AND **POLLUX**, twin sons of **LEDA**, when they were translated to the skies as stars.

GEMINI (gen. *Geminorum*), the twins, the third constellation of the Zodiac, visible all through win-

ter. It may be found high in the southern sky at 9 P.M. toward the end of February. The name undoubtedly derives from the two brightest stars **CASTOR** and **POLLUX**, Alpha and Beta Geminorum respectively. These are close together and nearly equal in brightness, and form a conspicuous contrast to the rather barren region to the north and east of them.

The dividing line between the first and second magnitude falls between these two stars. Castor, the fainter one is of the second magnitude, Pollux of the first. Actually Pollux, which is the nearer and yellower, is 28 times brighter than the sun, while Castor, farther away and whiter, is 34 times more luminous. Pollux appears to be single, while Castor is composed of four stars with two distant companions. Other interesting stars are Gamma, of the second magnitude, and Zeta of the fourth, a Cepheid variable with a period of 10 days. See **STAR: map**.

GEMSBOK (*Oryx gazella*), a large, handsome antelope of south and west Africa. It owes its striking appearance to its vivid markings and to the two slender, tapering horns, more than a yard long, that run backward almost parallel from the forehead in a very slight downward curve. The general color is tan-gray turning lighter on the under parts. The head is white with black bands, and there are other black bands and areas on its body. It is about 4 ft. in height. Gemsboks go in pairs or herds in high, rocky, barren desert regions and seem to be quite independent of water. Their spear-like horns furnish a weapon of defense against predatory animals. Both flesh and hide are esteemed.

GEM STONES, those minerals or stones which are prized as personal adornment. The qualities which make a mineral suitable for use as a gem are splendor or beauty, durability, rarity and fashion. A gem infrequently possesses all these qualifications, although the **DIAMOND** does to a marked degree and is therefore the most generally esteemed of **PRECIOUS STONES**.

The splendor or beauty of a stone depends upon its transparency, color, luster, brilliancy and fire. The first two qualities need hardly be discussed except to remark that color may be inherent in the composition of the mineral, or may be due to included impurities. The latter case usually prevails among gem stones. Luster refers to the appearance of the surface of a mineral by reflected light, and may be divided into metallic and non-metallic. The non-metallic may be further subdivided into splendent or adamantine, such as the brilliant surface shown by the diamond; and as vitreous or glass-like, pearly and other classifications. The brilliancy of a gem results from the light which is totally reflected within its interior, appearing to illuminate it from within. The fire is proportionate to its ability to break up white light into its spectroscopic components, as does a glass prism. The diamond is preeminent in this property. Opaque stones, as **LAPIS LAZULI**, are valued for their color.

The durability of a gem depends upon its hard-

ness. To be serviceable it should be harder than the dust particles floating in the air, which are usually of QUARTZ. Beautiful stones are frequently made unacceptable as gems because of their softness. Obviously rarity is prized in stones because of the human desire to possess articles not attainable by many individuals. Durable and beautiful minerals, such as the GARNET, are for this reason less in demand. Fashion has much to do with the vogue of gems, certain colors being popular for a period, or certain stones being esteemed because of their local occurrence. See also CRYSTALLOGRAPHY; ALEXANDRITE; AMBER; AZURITE; MINERALOGY; GEOCHEMISTRY; ANATASE; ANDALUSITE; QUARTZ; BERYL; APATITE; CHALCEDONY; CHRYSOBERYL; CORUNDUM; JADE; JET; MALACHITE; MORGANITE; MOONSTONE; OPAL; PERIDOT; RUTILE; SERPENTINE; SMITHSONITE; SPINEL; SPODUMENE; TOPAZ; TURQUOISE; ZIRCON; ZOISITE; PLAGIOCLASE; IOLITE. S. F. K.

BIBLIOGRAPHY.—George F. Kunz, *The Curious Lore of Precious Stones*, 1913; E. H. Kraus and E. F. Holden, *Gems and Gem Materials*, 1925; Fr. B. Wade, *Text-book of Precious Stones*, 1929.

GENDER, a grammatical category of the noun, adjective, non-personal pronoun and, in a number of languages, verb which classifies them as masculine, feminine, neuter, animate, inanimate, strong, feeble, etc., the number ranging from two, as in ROMANCE and SEMITIC, to 21 in Subiya BANTU. The most familiar grouping is threefold: masculine, feminine and neuter, as in Indo-Iranian, Greek, Italic, Old Irish and much of Germanic (see articles under these titles); and in English these genders actually correspond to sex-differences, *man* being masculine, *woman* feminine, *child* common (either masculine or feminine), and *thing* neuter. In most languages with gender, however, gender and sex seem by no means to correspond; the same idea being sometimes expressed in one language by one gender, and in another by another, as English *spoon* (neuter), German *löffel* (masculine), French *cuiller* (feminine). From the synchronic point of view, grammatical gender seems mere caprice; it can be explained only diachronically, i.e., historically (see SYNCHRONIC GRAMMAR; DIACHRONIC GRAMMAR). It would appear that INDO-EUROPEAN originally distinguished only two genders, animate and inanimate (these, of course, in accordance with early animistic views; see ANIMISM). Thus, Latin *fluvius*, "river," is masculine as representing water actively, i.e., as animate in that it flows; *flumen*, "river," is neuter as representing water in its inanimate and inactive sense of mere objectivity or collectivity. The animate included both male and female, sex being indicated by separate words, as in the very primitive type of *father: mother*. The origin of the feminine is obscure, but is almost certainly connected with the neuter plural used in a collective sense (cf. Latin *bona*, English *goods*, "property"), which had a singular force (in Greek, e.g., a neuter plural subject governs a verb in the singular), especially as the feminine is frequently also collective, as

Latin *laetitia*, "joyfulness" (cf. also *bona* "good[s]"), in form either feminine singular or neuter plural). It is also possible that the formation of the feminine declension was aided by coincidence of the termination *-a* with that of the feminine pronouns of the relative and demonstrative types, which seem to have indicated true sex from the very start. L. H. G.

BIBLIOGRAPHY.—L. Adam, *Le Genre dans les diverses langues*, 1883; H. Winckler, *Das grammatische Geschlecht*, 1889; K. Brugmann, *Nature and Origin of the Noun Genders in the Indo-European Languages*, 1897.

GENE, the hypothetical ultimate particle which perhaps by influencing the development of a particular part or organ of the body, is responsible for the production of a specific enzyme. The concept of such a particle is an old one and was rather highly developed by Darwin in his pangene theory and by Weismann in his germ plasm theory in which he referred to the particle as the determinant. The term gene was applied by Johannsen to one of these particles and this name was adopted by T. H. Morgan, whose researches, carried on jointly with Sturtevant, Bridges and Muller, have given experimental proof of Weismann's hypothesis. The genes are believed to be arranged longitudinally along the axis of the chromosome. John Belling has, indeed, observed in the chromosome of certain plants visible bodies which he thinks correspond in size and number with the postulated genes in this case. These exist in the chromosomes before the two maturation divisions, each in quadruple, anticipating already the two divisions. The gene has thus the remarkable capacity of doubling repeatedly—multiplying the number of genes indefinitely without a change of quality.

Ordinarily the gene is remarkably constant in its character and little affected by external conditions. However, by the use of X-rays and high temperature the gene may be modified in its function.

On the other hand, there are some genes which are naturally unstable, changing with relatively high frequency into certain other genes, as worked out by Demerec, both in the larkspur, *Delphinium*, and in the fly, *Drosophila*.

The number of genes in a chromosome varies with the species and the size of the chromosome. It has been estimated that a single chromosome of *Drosophila* may contain several hundred of them. The genes are believed to occupy the axis of the chromosome and are ordinarily more or less completely covered by the staining substance, chromatin, of the chromosome.

Each gene ordinarily occupies a definite position in the chromosome and its position may be mapped with considerable accuracy. However, genes occupying the same point in the chromosome frequently produce what are known as multiple allelomorphs or mutations. It seems probable that in such cases the complex molecules of the gene undergo multiple changes, thus producing progressive changes in the quality of the gene and, therefore, in the work that it does in directing development. C. B. D.

GENEALOGIST, one whose occupation it is to trace back ancestry in natural order, to study the descent of an individual or family tree, to record a pedigree, or to find the heir to an estate. A genealogist must have the patience for long, careful research and a liking for history.

GENERAL, the highest title and rank of military officers. It is conferred only by a special act of Congress and until the World War had been possessed only by Washington, Grant, Sherman and Sheridan. Officers commanding units larger than a regiment are termed general officers and include, besides generals, lieutenant generals, major generals, and brigadier generals. The lieutenant general ranks next to the general and ordinarily commands an army corps. A major general is next in rank, commanding a division. In 1917 John J. Pershing was made (emergency) general of the U.S. Army, and the title was confirmed in 1919.

GENERAL BOARD OF THE U.S. NAVY, a body composed of the Chief of Naval Operations, the Major General Commandant of the Marine Corps, the Director of Naval Intelligence, the President of the Naval War College and such additional officers as the Secretary of the Navy may designate. An officer above the grade of lieutenant in the Navy is detailed as secretary.

A fundamental difference exists between the bureaus of the Navy and the General Board, in that each bureau views its work with reference to its specialty as a part of the Navy Department with subordination to the national policies as a background, whereas the General Board views the questions before it taking the Navy as a whole to be harmonized with other efforts of the government in behalf of the nation, with a background of the world controlled by interests other than those of the United States and sometimes hostile thereto. Herein lies the vital value of the Board to the Navy and the nation.

The Navy Department had been a branch of the War Department from 1794 until formed into an independent department by Congress in 1798; yet its organization was so elementary that it was scarcely a navy department in the true sense of the word until the organizing Act of 1815 following the close of the War of 1812.

This condition of affairs continued down to the time that war with Spain seemed unavoidable. War was about to be declared before Secretary Long had succeeded in bringing together the so-called Naval War Board of 1898.

With the close of the Spanish-American War, the War Board of 1898 quietly went out of existence.

The duties of the General Board as laid down in general order, No. 544, dated Mar. 13, 1900, establishing it, were defined as follows: "The purpose of the Department in establishing this Board is to insure efficient preparation of the fleet in case of war and for the naval defense of the coast."

Admiral Dewey was made the President of the Board and retained the presidency until the day of

his death, Jan. 16, 1917. He met with the Board on matters relating to the United States' entrance into the World War just a week before he passed away, and in tribute to his memory there has never been a president appointed to that office since, the senior member officiating as such.

The same conditions obtain in the General Board that marked the Naval War Board of 1898, in that it exists without authority of Congressional law, although acts of Congress have recognized it. It may be abolished at any moment by order of the Secretary of the Navy, by whose order it was created. It is without administrative duties and is purely advisory.

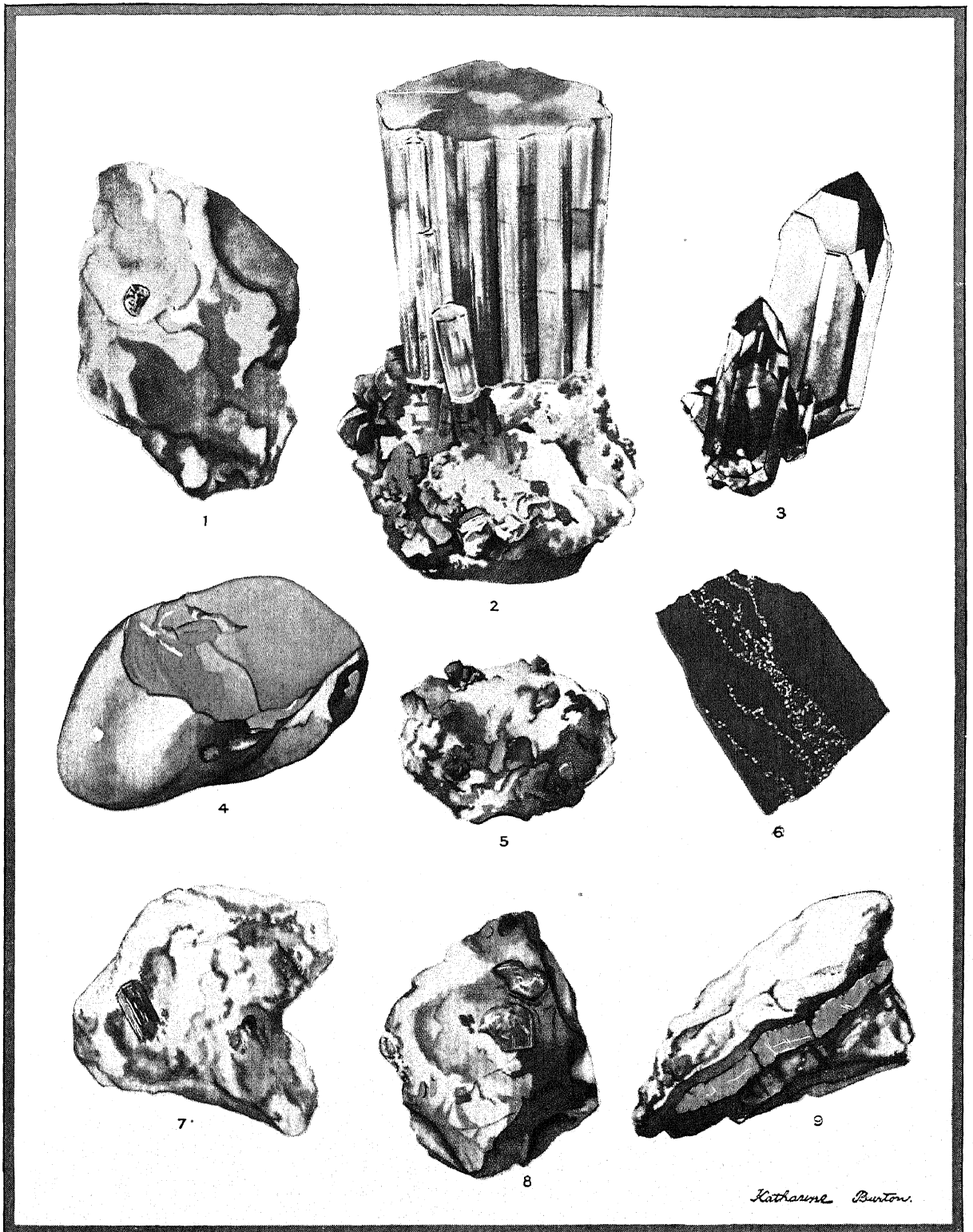
In 1916, Congressional action created the office of Naval Operations. This affected the General Board's functions in that the new organization assumed the responsibility for executive plans for mobilization and for war, and the General Board was left purely as a consultative body for the consideration of matters of general policy of the Department where careful study was needed. In consequence, the position of the General Board is that defined in Naval Regulations, i.e., "The General Board shall be furnished, for information, with the approved War Plans, including cooperation with the Army and employment of the elements of naval defense. It shall consider the number and types of ships proper to constitute the fleet and shall advise the Secretary of the Navy respecting the same, including such increase as may be requisite, to be submitted annually to Congress. It shall consider and report upon such subjects as the Secretary of the Navy may lay before it." In compliance with these regulations, one of the principal duties of the General Board is to initiate the building program of the Navy.

In the Board's problems of ship building and, in fact, naval policy, the treaties of the WASHINGTON CONFERENCE of 1921-22 and the LONDON CONFERENCE of 1930 have made a profound change. From being a treaty-free Navy, the Navy is now treaty-bound. The difference is very great and of tremendous importance. The United States can no longer build ships of a design which seems to it to be desirable, but only such ships as are desirable within the terms of the treaties. Thus the treaties are the actual and invariable basis for all the design work of the bureaus and the General Board. Before coming to a decision, the General Board holds exhaustive hearings of representatives of the bureaus, the fleet, and others, military, naval and civilian, who have special and technical knowledge of the questions under discussion. Facts determine the final action of the Board.

R. E. C.

GENERAL EDUCATION BOARD, a foundation established by JOHN D. ROCKEFELLER in 1902, to promote education within the United States "without distinction of race, sex or creed." The board was incorporated by Act of Congress in 1903. Its main activities have been promotion of higher education; cooperation with state universities in the development

GEM STONES



Katherine Burton.

COURTESY AMERICAN MUSEUM OF NATURAL HISTORY

VARIOUS GEM STONES AS FOUND IN NATURE

1. Crystal of diamond in Kimberlite, or "Blue Ground." 2. Crystals of tourmaline, variety rubellite. 3. Smoky quartz crystals. 4. Nodule of opaque amber. 5. Crystals of ruby in limestone.

6. Lapis-lazuli, seamed with pyrite. 7. Crystals of emerald in matrix. 8. Fire opal in rhyolite. 9. Vein of turquoise.

of public high schools, rural schools and schools for Negroes in the southern states; development of medical education; promotion of efficient farming in the South, and furthering educational research and experimentation. Rockefeller's gifts have amounted to more than \$127,000,000. In addition \$200,000 was given the board in 1905 by Miss Anna T. Jeanes, "for the assistance of the Negro rural schools in the South." Up to June 30, 1930 the board had appropriated over \$214,777,796, divided approximately as follows: college education, \$87,154,319; medical education, \$78,862,328; Negro education, \$26,851,376; public education, \$10,912,429; other activities \$10,997,344. From the date of its establishment, it has been the policy of the board to limit its activities to such phases of education as seem most in need of improvement and which give promise of successful results.

GENERAL GRANT NATIONAL PARK, a tract of 4 sq. mi. in east central California which was set aside by Congress Oct. 1, 1890. The park contains a magnificent grove of Big Trees, *Sequoia gigantea*, chief of which is the famous General Grant Tree. This tremendous monarch of the forest, 40.3 ft. in diameter, was dedicated a few years ago as the nation's Christmas Tree.

From Fresno and Visalia, both on the Santa Fe and Southern Pacific railroads, the park is easily reached on excellent mountain roads which are a part of the National Park to Park Highway system. Visitors may drive through the park and there are extensive foot and horseback trails. General Grant park is 31 mi. by trail from SEQUOIA NATIONAL PARK.

GENERAL PRICE LEVEL. See INFLATION AND DEFLATION; STABILIZATION.

GENERAL PROPERTY TAX. See PROPERTY TAX, GENERAL.

GENERAL STAFF. See GENERAL STAFF CORPS, U.S. ARMY.

GENERAL STAFF CORPS, U.S. ARMY, an administrative department of the ARMY comprising the CHIEF-OF-STAFF, the War Department General Staff and the General Staff with Troops.

The War Department General Staff is charged with preparing plans for the development and execution of the Army program, including the details for mobilization of the manhood of the nation in war. It inquires into all questions affecting the efficiency of all branches of the Army. This includes the necessary plans for recruiting, organizing, supplying, equipping, mobilizing, training and demobilizing of the Army of the United States for national defense. There are five divisions of the General Staff, each under the control of an Assistant Chief-of-Staff: Personnel Division (G-1); Military Intelligence Division (G-2); Operations and Training Division (G-3); Supply Division (G-4); War Plans Division (WPD).

The General Staff with Troops consists of those officers that are assigned to general staff duty in the field. During times of peace they are at the headquarters of the various corps areas and divisions. The general staff organization at headquarters of corps

areas is the same as for the War Department. At the headquarters of smaller units the general staff is divided into four divisions, among which all duties of a general staff nature are distributed.

Shortly after the World War, an initial War Department General Staff Corps eligible list was prepared from all officers of the Army. Officers on this list are eligible for all general staff duties. To be eligible for general staff with troops duty, the officer must be a graduate of the Command and General Staff College at Fort Leavenworth, Kan., and approved for such duty by the War Department. To be eligible for the War Department General Staff, an officer must, in addition to the requirements for general staff duty with troops be a graduate of the Army War College, Washington, D.C. S. J.

GENERAL STRIKE. See STRIKE, GENERAL.

GENERATIVE ORGANS, the system of structures of the human body which are specialized for reproduction.

Male Generative Organs. The male generative organs are adapted to formation of germ cells and the deposition of them at the mouth of the uterus of the female so that they may unite with the egg cell, a new individual thereby being formed in the body of the female.

The germ cells, spermatozoa, are formed in the semeniferous tubules (Fig. 1, S.T.) of the testis (*Tes.*). The testes are contained in a pouch, the scrotum (*Scr.*). The sperms begin as large cells which multi-

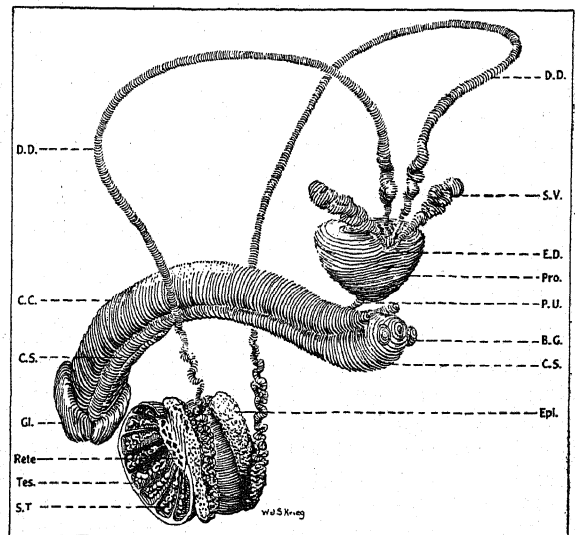


FIG. 1. RECONSTRUCTION OF MALE GENERATIVE ORGANS

B.G., bulbourethral gland; C.C., corpus cavernosum; C.S., corpus spongiosum; D.D., ductus deferens; E.D., ejaculatory duct; Epi., epididymis; Gl., glans; Pro., prostate; P.U., prostatic urethra; Rete, rete of testis; S.T., semeniferous tubules; S.V., seminal vesicle; Tes., testis

ply in the semeniferous tubules. They then develop a long motile tail and are liberated into the spermatic passages. On leaving the semeniferous tubules, they pass into a labyrinth in the testis, the rete testis (*Rete*). A number of convoluted tubes lead out from the testis. These later combine into a single highly contorted

tube, constituting the epididymis (*Epi.*). Having passed through these channels, the sperms enter the long ductus deferens (*D.D.*) which conducts them into the pelvis.

The ductus deferens runs alongside a large number of veins, arteries and nerves supplying the testis. These constitute the spermatic cord. Frequently the veins of the spermatic cord become varicose and enlarged, forming a varicocele. The spermatic cord passes upward from the testis, alongside the penis, and into the groin. Here it perforates the three muscles of the abdomen as it passes laterally. Once in the abdomen, it turns toward the mid-line and the ductus deferens enters the prostate (*Pro.*) below the urinary bladder (*Bl.*). Just as it enters the prostate, a pouch with a narrow opening is attached to it. This is the seminal vesicle (*S.V.*). Contrary to a previous belief, the sperms are not stored here. They are forced out of the epididymis and ductus deferens by a rhythmic contraction of the muscular walls of these passages. The portion of the duct between the seminal vesicle and the junction with the urethra is the ejaculatory duct (*E.D.*).

When the sperms have been discharged from the ductus deferens, they enter the urethra, which is the passage conducting urine from the bladder (*Bl.*). The urethra is divided into several portions. That part in the prostate is termed the prostatic urethra, while the segment in the penis is the cavernous portion.

The penis, besides serving as part of the urinary system, is filled with tissue containing large sinuses connected with the blood vessels. The upper portion of the sinuses are termed the corpora cavernosa, while that immediately surrounding the urethra is the corpus spongiosum. The latter is expanded into a bulb at the end of the penis, the glans. A fold of skin, the foreskin or prepuce, protects the tender glans.

Female Generative Organs. The female generative organs are adapted to the formation of the egg and the protection and nourishment of the growing embryo.

The eggs or ova are developed in the ovary (Fig. 2, *Ov.*). The ovaries are two in number, and are located on either side within the cavity of the pelvis. As the egg approaches maturity, the thick layer of cells around it split and the cavity becomes filled with fluid. This cavity enlarges greatly until it approaches the surface of the ovary (*O.F.*). This is the ovarian or Graafian follicle. Finally, the follicle bursts, and the ovum is discharged into the abdominal cavity.

Though the ovum is destined to reach the uterus or womb (*Ut.*) by way of the uterine tube (*U.T.*), it is interesting to note that it is not discharged directly into the tube, but instead freely into the abdomen. However, it practically invariably reaches the expanded open end of the long uterine or Fallopian tube, which by means of the active cilia within it, carries the egg into the uterus.

The uterus is a flattened pear-shaped structure with a length of three inches, a breadth of two inches,

and a thickness of one inch. It lies in the pelvis in the mid-line, above the bladder, above and behind the pubic bone. It is hollow, but has a thick muscular wall and many blood vessels. The two uterine tubes open into either side at the top. At its apex, directed downward, it opens into the vagina (*Vag.*),

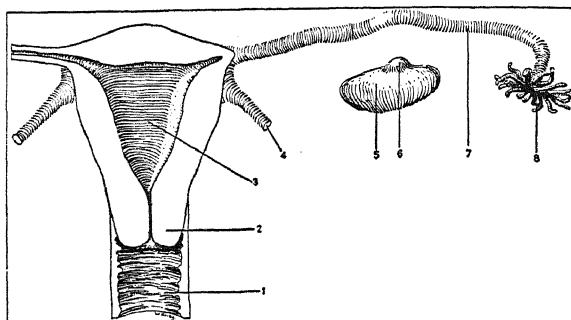


FIG. 2. THE FEMALE GENERATIVE ORGANS

1 Vag., vagina; 2 Cer., cervix of uterus; 3 Ut., uterus (longitudinally sectioned); 4 R.L., round ligament; 5 Ov., ovary; 6 O.F., ovarian follicle; 7 U.T., uterine tube; 8 Fim., fimbriated end of ovarian tube

which is a large tube open to the exterior. The sperms deposited in the vagina arrive at the lower end of the uterus, the cervix (*Cer.*), and enter the uterus by the opening referred to above.

If a sperm succeeds in uniting with an egg cell, the cell formed from the union divides into a number of cells which form an embryo. The embryo becomes attached to the wall of the uterus, in order that it may extract nourishment from the blood stream of the mother. The uterus enlarges with the embryo until it has reached relatively enormous proportions. After nine months of development, the child is born by being expelled through the vagina (*see* OBSTETRICS; EMBRYOLOGY).

In the human species sexual maturity is not reached until after the first decade of life. At this time the internal secretions of the sex glands develop the sexual characteristics and the germ cells begin to be matured. In the female, coincident with sexual maturity, there is a periodic expulsion of the lining of the uterus together with some blood. This monthly discharge, MENSTRUATION, is correlated with the maturation of the egg. Menstruation serves to prepare the congested uterus for the possible implantation of the fertilized egg. During middle age, the menses cease in women, sperms are no longer produced in men, and sexual functions become inactive in both sexes. (*See* CLIMACTERIC.)

For malformations in the generative organs in the newborn, *see* CHILDREN, DISEASES OF: Prenatal Diseases.

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GENERATOR, ELECTRIC. *See* ELECTRIC GENERATOR.

GENESEE RIVER, a river of New York State, rising in Potter Co., Pa. It enters New York in Allegheny Co. and flows almost directly north until it empties into Lake Ontario at Charlotte, 7 mi. north of Rochester. At about the middle of its course it

flows for 20 mi. through a deep, precipitous gorge cut in sandstone cliffs which at places are 350 ft. high. The fall of the river here is over 500 ft. including three cascades of 65, 90 and 110 ft. The latter is named Portage Falls. At Mt. Morris in Livingston Co. the river leaves the gorge and runs through the broad and open country of the Genesee valley, a fertile agricultural district. When it reaches Rochester where it is crossed by the ERIE CANAL, its bed is cut by three more cascades of 96, 26 and 83 ft., which offer unlimited water power to the manufactures of that city. The Genesee is about 140 mi. long. Its chief asset is its water power since it is navigable for but 5 mi. above its mouth.

GENESIS, BOOK OF, the first book of the Bible, is the earliest part of the subdivision known as the Pentateuch, or the *Torah*, or the books of Moses. Its name is derived from its title in the Greek version, *genesis kosmou*. The first chapters contain the early stories of mankind, as they were believed by the people for whom they were written, including the story of the Creation, of the origin of evil, of the birth of civilization, of the great deluge, of the beginning of languages, and particularly, of the origin and early experiences of the Semitic race. The second division of the book, beginning at Chapter 11:27, gives the history of the fathers of the Hebrew race, Abraham, Isaac and Jacob, or Israel, with the latter's 12 sons, who, as the children of Israel, are said to have begotten the 12 tribes of the future Hebrew nation. The second division stresses frequently the theme that they will multiply "as the stars in the heaven and as the sand which is upon the sea shore." Most modern scholars adhere to the theory that the book is the product of the editorship of several documents, dating from the 9th to the 7th centuries B.C., its stories being such as might be collected from traditions, and told with a freedom and spirit commonly associated with folk tales. The conservative views the book as the work of the Mosaic period, admitting in part, the existence of post-Mosaic additions and changes.

GENÊT, EDMOND CHARLES (1765-1834), French diplomat, was born at Versailles, Jan. 8, 1765. He served France in the embassies of Berlin and Vienna, but early developed republican sympathies. In 1788 he went as chargé d'affaires to St. Petersburg but his outspoken liberalism displeased Catherine II and he received his passports in 1792. He was accredited to the United States as minister-plenipotentiary early in 1793, and arrived in Charleston, S.C., in April. (See GENÊT'S MISSION.) Washington obtained his recall early in 1794. Fearing his fate as a Girondist if he returned to France, Genêt became an American citizen, and married a daughter of Gov. Clinton of New York. He died at Schodac, N.Y., July 14, 1834.

GENET (*Genetta*), an animal belonging to the family *Viverridae* and generally considered as a distinct genus from the civet (*Viverra*). The genet is smaller than the civet, and its distinctive odor is not

so strong. Its fur of commercial value is gray, spotted with black or brown, the tail being of about the same length as the body and ringed with black and white markings. There are six species of genet usually recognized and five of them are found exclusively in Africa, but the common genet is found in southern Europe, western Asia, and in northern Africa. It is generally found on the banks of brooks and streams and is capable of being trained for catching mice. It has sometimes been used as an heraldic figure.

GENETIC PSYCHOLOGY, a type of psychology that aims to study mental life from the standpoint of its origin and development. It adopts the evolutionary point of view and traces the growth of psychic life both in the individual and in the race. This is but another way of saying that it adopts the genetic method of approach to the subject matter of psychology, from which it gets its name.

The two main divisions of genetic psychology are individual and group psychology. From the standpoint of the individual, it takes the form of child psychology. Group psychology is in turn divided into sub-human and human psychology, the former being known as race psychology and the latter as folkpsychology. Child psychology traces the growth and development of the mental life of the child; race psychology includes animal psychology, while folkpsychology studies the customs and institutions of primitive peoples from a psychological point of view.

GENETICS, the science which deals with the phenomena of variation and inheritance and their relation to the evolution of organisms. Genetics has to do with the way in which the species reproduces its traits, the manner in which new forms of life arise, and the way in which species change.

It is a fundamental principle of genetics that different species of organisms are undergoing constant change. Genetics is concerned with the laws of such change. The first principle of genetics is that of inheritable variation or mutation. Mutations arise from at least two different causes. First are the changes that occur in the genes,—those small chemical packets, vast numbers of which are found in each of the chromosomes of the cell nucleus. The exact number of these genes is not known for any species; sometimes 500 or more in a single chromosome. In man there are 24 different chromosomes, from each parent 24 pairs, and possibly there are 10,000 or more genes in his make-up. How the gene influences development is unknown, but perhaps it is by its special control over metabolic activity or assimilation, and thus by the upbuilding of the individual. A particular gene may be chiefly responsible for a particular organ, tissue or other trait. It is in constant collaboration with other genes whose action it may enhance, or otherwise modify; so that the body is not merely a patchwork of the action of so many thousand independent genes, but is the resultant of the collaboration between them all.

When a gene undergoes mutation, it may become

modified in some way or it may become entirely eliminated. A single gene may become modified in several directions, or in several grades in the same direction, so that it may give rise to several types of mutants.

A second kind of mutation is associated with changes in the chromosome, as a whole, rather than with individual genes. Although the number of chromosomes is commonly fixed in a species, in some species that have been most intensively studied the chromosomal complex has been shown to undergo frequent and striking changes, chiefly in number of constituent chromosomes. Thus in the Jimson weed, *Datura Stramonium*, where there are ordinarily 12 pairs of chromosomes, there may be added an extra chromosome to any one of the 12 pairs, resulting in 25 chromosomes and making possible 12 new types, all differing from the standard. Or chromosomes may divide into fragments in various ways and the fragments may make abnormal connections with each other. In consequence of such abnormalities in interrelation, there are corresponding abnormalities in inheritance and in the development of the individual. Inheritance in this case is irregular or unpredictable in the Mendelian sense; for with each chromosomal mutation many genes and many characters are involved. While gene mutation and chromosome mutation are the only two types that have been studied by geneticists, it is possible that inheritable changes may occur in the cytoplasm of the egg which may modify its development.

Although the old idea that the agents of the environment act in a specific way to modify the germ plasm in adaptive fashion has received no support from experimental work, mutations can be induced by external agents. Thus radiations and even extremes of temperature may affect the relations of chromosomes to each other, inducing chromosome mutations. Radiation may even affect particular genes, thereafter exercising different control over development. Since the world is full of rays constantly penetrating into organisms, it seems possible that mutation of all sorts is being induced by radiant energy, just as many inorganic chemicals, subjected to even diffuse rays of light, undergo a gradual change or deterioration. Genes and the germinal substances in general are exceedingly labile. They do not long remain unaltered. Consequently the chromosomal substance is constantly mutating and species are undergoing constant change. Mutation is one of the constant phenomena in organisms and is an important factor in their gradual evolution. The second genetical factor is that of heredity, or persistence of mutations through the generations. The mechanism for this persistence is found in the CHROMOSOMES.

Mutations are so universal and constantly recurring that it would be expected the number of kinds of individuals would be indefinite and that they would form a chaotic ensemble. Instead of this there are only about a million organisms which have been

recognized as distinct, although no doubt more careful attention to organisms would increase this number a hundredfold. The reason for this limitation in the number of chromosomes in the midst of universal mutation is certainly, in part, due to the fact that most mutations render the organism less viable. Many indeed insure its early death. A successful mutant, such as all widespread species represent, is one whose organs developed under the control of genes are, in all their functions, compatible with the conditions imposed by environment. Since mutations arise without regard to the demands of environment most of them will be opposed to such demands.

If the environment is repeatedly changing, or if the organism can be widely disseminated into a variety of environments, new functions may prove to be adaptive, possibly even more adaptive than those possessed by the individual before mutation. For the number of kinds of environment is, after all, finite, and so the number of kinds of organisms that can survive is finite also.

The modern study of genetics coincides with the twentieth century. A start was obtained under the stimulus of the great work of De Vries on mutation and of Mendel, as re-discovered by De Vries, Correns and Tschermak. The importance of the new subject has become recognized through the establishment of research institutions devoted to genetics of plants, animals and man, of numerous societies devoted to eugenics and genetics and of university chairs on the subject. At the last international genetics congress held in Berlin, there were nearly 1,000 interested persons in attendance. The genetic viewpoint, according to which the idiosyncrasies of species and individuals, including men, are largely due to idiosyncrasies in development depending upon gene peculiarities, has thrown a new light upon many old problems of organic differences.

GENÊT'S MISSION. In 1793 Edmond Charles Edouard Genêt, a Girondist, was commissioned by the French Republic Minister Plenipotentiary to the Congress of the United States, and instructed to induce the United States to declare war against Great Britain. He landed at Charleston, S.C., Apr. 8, 1793, and was enthusiastically received there and at Philadelphia, where democratic sentiment was strong. He issued letters of marque and reprisal to Americans wishing to engage in PRIVATEERING against British commerce, issued military commissions to GEORGE ROGERS CLARK and others, and planned expeditions of American volunteers against English and Spanish possessions in North America. President Washington balked Genêt's mission by issuing his famous NEUTRALITY PROCLAMATION, and received Genêt coldly. On June 5 Secretary of State Jefferson notified Genêt to cease arming and equipping privateers in American ports. Genêt disregarded the order, virulently criticised Washington, and demanded an extra session of Congress to treat with him. Genêt was recalled, and the Girondists having lost power in France, a successor, "Citizen" Fauchet, was sent with orders for

Genêt's arrest. Washington refused to permit the extradition, and Genêt, abandoning his mission, took up permanent residence in New York.

GENEVA, a city of Switzerland, capital of the canton of the same name at the southern point of Lake Geneva, where the Rhone emerges. Mentioned by Julius Caesar, its territory became a Roman province in 120 B.C., and capital of the Burgundians in 443. It fell to the Franks in 534, at the end of the 9th century to the new Burgundian Kingdom with which in 1032 it became part of the German Empire. The citizens gained many privileges during the long struggles between the bishops, the imperial courts and those of Savoy, in the midst of which came the Reformation and Calvin. After further vicissitudes, it became a member of the Swiss confederation in 1814. There are beautiful promenades on the lake front with imposing modern buildings and fine parks, offering marvelous views of Mont Blanc and other peaks of the Alps. Many fine monuments and fountains adorn the city and among the buildings, the cathedral in Byzantine style, completed in 1124, the Gothic Maccabee Chapel, 1406, modern churches, both Russian and English, the city hall, the university, the Kursaal, and Calvin's and Rousseau's former homes are notable. There is considerable trade in agricultural products and manufactures, particularly watches, and as one of the most beautiful European cities, it attracts large numbers of visitors. Geneva is the seat of the LEAGUE OF NATIONS, the International Labor Bureau and the International Red Cross, as well as of 27 learned societies. Pop. 1930, 143,352.

GENEVA, a city in Ontario Co., central New York, situated on Barge Canal at the north end of Lake Seneca, about 50 mi. southeast of Rochester. The State Barge Canal, electric trolleys, buses and the New York Central and Lehigh Valley railroads afford transportation. Geneva is a trade center with many important manufactures including optical supplies, enamel ware, machinery, canned products, stoves and boats. The manufactured output, 1929, was valued at \$12,088,338. The retail business in 1929 amounted to \$10,179,469. Cabbages and fruit are the chief crops of the district. Geneva has many large nurseries and the State maintains an Agricultural Experiment Station. Hobart College for Men and William Smith College for Women are located here. The city is in the beautiful Finger Lakes region, which is noted for its attractive summer resorts. The first settlement was made in 1792. Pop. 1920, 14,648; 1930, 16,053.

GENEVA (LEMAN), LAKE, in central Europe, situated on the border between Switzerland and France, on the northern margin of the Alps. It is roughly crescent-shaped, the east end being rounded and much broader than the west, which tapers to a point at the city of Geneva. Its length is over 40 mi., its area 224 sq. mi., its width exceeds 8 mi. at its maximum, and its greatest depth is over 1,000 ft. Lake Geneva is the largest body of fresh water in central Europe. Normally high above the sea, when the snow melts the lake experiences a quite perceptible

rise. *Seiches*, sudden oscillations of water, probably caused by changes of atmospheric pressure which temporarily change the level, occur at times. The lake has never frozen over completely. The Rhone River flowing into it from the east and out at the west end is the most important of a score of affluents. The intensely deep blue of Geneva's waters together with the general beauty and majesty of the surrounding country have attracted visitors and residents to the lakeside for hundreds of years. Mt. Blanc, 40 mi. distant, is not only visible, but is at times reflected in its waters. The chief towns along its shores are Geneva, Lausanne, Vevey, Montreux, Nyon and Morges, between which there is steamboat communication.

GENEVA CONFERENCE, a three power arms conference, American, British and Japanese, held at Geneva, Switzerland, in June-Aug. 1927. Hugh Gibson, head of the American delegation, was elected president. The main subjects of discussion were whether the Washington Treaty ratios should be made to apply to auxiliary vessels, divided into three classes, cruisers, destroyers and submarines, subject to limitation, and to noncombatant vessels of negligible value, the definition of same to be agreed on. Each of the three powers made known the desires of its government as to the three classes, with certain other changes recommended for consideration on the part of two powers. The Conference adjourned without agreement. Another arms reduction conference was held at Geneva in 1932. R. E. C.

GENEVA CONVENTION, the first of a series of international agreements covering the treatment of wounded in war, made at Geneva in 1864 by representatives of the great European powers. The meeting was the result of a booklet by Henri Dunant describing the horrors suffered by the wounded in the Italian Wars. From the conference resulted the organization of the Red Cross Societies and international agreements guaranteeing the inviolability of their hospital services. Further conferences at Geneva in 1868 and 1906 elaborated the agreement. See RED CROSS.

GENEVIEVE, ST. (c. 422-512), was born at Nanterre, France, about 422. She is said to have dedicated herself to a life of religion at the age of seven. On the death of her parents she settled in Paris where she engaged in works of charity. She appears to have obtained much influence owing to her successful prophecies. St. Genevieve predicted the invasion of the Huns, and further, that Attila would not succeed in his attack on Paris. She died in Paris in 512 and was buried in the church popularly called St. Genevieve. Her relics are now in the church of St. Etienne du Mont. Her festival falls on Jan. 3.

GENISTA, a genus of shrubs of the pea family comprising upwards of 100 species found in Europe, the Canary Islands, northern Africa and eastern Asia. A few of these are grown in borders for their handsome yellow or white pealike flowers. The genista of florists (*Cytisus canariensis*), a soft-hairy, much-branched evergreen shrub native to the Canary Islands,

belongs to a closely allied genus. It bears small leaves divided into three leaflets and dense clusters of bright yellow flowers.

GENIUS, PSYCHOLOGY OF, the study of the origin, nature and laws of development of exceptionally gifted individuals. The anecdotal method, as illustrated by the writings of Moreau de Tours and CESARE LOMBROSO, characterized most of the early literature on this subject. Within the last half century, however, a more strictly scientific approach to the problems of superior capacity and precocity has been provided. Galton's (*See* GALTON, SIR FRANCIS) *Hereditary Genius*, 1869, together with such studies as those of JAMES McKEEN CATTELL, HAVELOCK ELLIS, Woods and Freeman have paved the way.

A wide diversity of opinion exists among students of genius as to its origin. We have theories ranging all the way from those of the extreme environmentalists on the one hand to those of the equally extreme advocates of the hereditary nature of genius on the other, through the theories of the more conservative group, who would prefer to admit that both environment and parentage are operative. Assuming that genius involves the productive utilization of inherent ability in addition to the mere possession of such ability, most present-day psychologists adhere to the more conservative position; for case studies of talented individuals indicate that, while it is true that eminent persons are practically always of superior mentality, the converse of this statement does not hold. That Galton was correct in his primary findings that eminent men tend to appear predominantly in family stocks of decidedly superior intellectual endowment is not to be questioned. In fact, this conclusion has been given additional substantiation within late years by the finding that the siblings as well as the forebears of talented persons are also markedly above average in intelligence. This, however, does not invalidate the proposition that a superior environment is the rule in the cultivation and production of genius.

Characteristics of Genius. As an approach to the problem of the conservation and development of latent genius, the attention of psychologists and educators has been directed in late years to the determination of the nature and characteristics of genius. Much material has been made available on this point through the *Genetic Studies of Genius* being carried forward at Stanford University, under the direction of LEWIS M. TERMAN, whereby the life histories of some 1,000 gifted children of California are being very carefully followed. Mrs. Catherine Cox Miles's study of the heredity, childhood and youth of 301 of the most eminent men and women of history, through the medium of both original and secondary biographical sources, has also shed much light upon the psychological characteristics of more gifted individuals.

The question of the normality of genius has been the center of much discussion. Certain students of the problem have insisted that genius is closely related to insanity, an abnormal and more or less perverted deviation from the normal type. In fact, the

Lombroso School has gone so far as to intimate that we may quite warrantably classify all cases of precocity as cases of insanity. By this definition the man of genius is at once labeled as abnormal. Galton's more conservative and to-day more widely accepted view is that genius falls at the upper extreme of the distribution of intelligence just as idiocy falls at its lower extreme. It is, therefore, a perfectly normal phenomenon and not to be regarded as indication of a mental aberration.

Contrary to general opinion and to the conclusion of some of the earlier students of the subject, the gifted individual is prone to excel in physical as well as mental endowment, although not so markedly in the former as in the latter. In the results of the Stanford study up to 1932, "there is no shred of evidence to support the widespread opinion that typically the intellectually precocious child is weak, undersized, or nervously unstable." Neither have the children of the Stanford project shown themselves to be deficient in other aspects of personality. Their interests are varied, play interests are wholly normal, social intelligence ratings are normal or superior, and social adaptability is up to par. They also rank well above the average in practically all character traits measured. The essential validity of these conclusions is borne out by Cox's study, which indicates that "youths who achieve eminence are characterized not only by high intellectual traits, but also by persistence of motives and effort, confidence in their abilities, and great strength and force of character."

Relation to School Work. Naturally the precocity of the budding genius is brilliantly reflected in the quality of his school work. He is usually accelerated in school progress, but seldom as much as his capacity warrants. This acceleration is most marked in the reading of the gifted child. Cases are on record of precocious individuals who learned to read as early as 21 months, and "the typical gifted child of seven reads more books than the unselected child reads at any age up to 15 years." Notable cases of early exhibitions of musical genius are numerous. Although many problems pertinent to proper educational procedure in the cultivation and conservation of genius still remain to be solved, a substantial beginning has been made. Special classes, differentiated curricula, individual instruction, honors courses and project courses are all attempts to deal with these problems. Indications are that further reforms will not be long in coming. It is most imperative that provisions be made for the recognition of talent early in the curriculum, since the superiority of the gifted child exhibits itself at a very early age. In fact, studies of the early childhoods of the world's geniuses indicate that reforms are perhaps most needed at the pre-school level, since "youths who achieve eminence are distinguished in childhood by behavior which indicates an unusually high I.Q."

Judging from historical evidence, genius is predominantly a male characteristic, the ratio of eminent men to women being in the neighborhood of 9 to 1. This

fact is particularly significant when viewed in the light of the fact that in a group of pre-high school gifted children the proportion of males to females is practically equal, with the boys slightly in the majority. At the high school level this majority grows until at the adult level the population of precocious individuals is overwhelmingly male. An early cessation of mental growth on the part of the girls has been suggested as a possible explanation of this phenomenon, and there is some experimental evidence to support it.

According to Cattell's calculations, the countries of northern Europe rank highest in the production of men of genius up to the beginning of the 20th century, at least in so far as eminence is significant of genius. France, Britain and Germany head the list, with Italy and Greece next in line. Due in part, at least, to her comparative youth, America is sixth. The indications are that she will rise to first place during the present century. Spain, Switzerland, Holland, Sweden and Russia follow America. These conclusions tally well with findings concerning the relative intelligence of various races and nationalities, the Teutonic and Anglo-Saxon stocks ranking well above those of other parts of the world.

P. Mu.

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GENIZA, a Hebrew common noun derived from the verb *ganaz*, and employed as a term to denote successively the act of concealing or storing, the storeroom for unused books and manuscripts and, finally, the MSS. themselves. The word has since 1897 become almost a proper name for the immense collection which came from Fostat, the old Cairo in Egypt. It had been kept there for centuries, carelessly and in disorder, in a special room in the Synagogue of Ezra the Scribe, a Jewish place of worship, the history of which goes back to the 7th century when, soon after the conquest of Egypt by the Persians, 616, it was remodeled from a church. Only within the last 50 years has the inestimable value of this collection been rightly appreciated.

Origin and Development. The origin and development of a Geniza are not difficult to trace. The respect with which the Jewish people have always viewed the written word, particularly if it is in Hebrew, or at least in Hebrew characters, led them to dispose of unused writings in an unusual fashion. Instead of destroying them by burning or tearing they chose to "hide" them, that is, to lay them in a depository specially appointed for this purpose. From references in Talmudic literature we learn that this practice was already in use in pre-Christian centuries. The rabbis also prescribed that Scrolls of the Law in which God's name appears are to be laid away. The custom has prevailed to our own day. Most synagogues provide some place, whether it be in the cellar, on the roof, or under the pulpit, as a temporary lodging for unwanted texts. Torn prayer

and study books, stray leaves no longer usable, documents which have outlived their purpose, all find shelter in those quarters. Gradually the heap grows, a motley pile in which the most unrelated subjects are intermingled. But this is not their final resting-place. When the occupied space is required for new arrivals, most of the old material is cleared out and brought to the burial ground where it finds its eternal home next to the grave of some venerated scholar. The ceremonies attendant upon this interment bear a religious character. The sacredness of the writings does not depart from them until they are brought to rest.

However, not all MSS. are buried. Where the storeroom is spacious enough to permit amassing, or where the material does not readily accumulate, discarded material may continue to lie where first deposited. There are many such storerooms in existence, and none of them is entirely devoid of interest. Local documents are always likely to turn up among those collections, which will help enrich the knowledge concerning the various communities. The numerous histories of Jews in European cities which draw on original sources very frequently utilize sundry papers and documents which were believed to have outlived their usefulness and were therefore discarded. But the interest attaching to a Geniza is incomparably greater if it is situated in a community that boasts a long history. As we recede further into the centuries, original writings become rarer. Secular treatises naturally and regrettably vanish after the sect itself has breathed its last; polemical pamphlets which betray heretical views are consciously and systematically stamped out together with the heresy which engendered them. This unfortunate truth, coupled with the readily comprehensible eagerness to recover as much as possible of all the material which issued from the pen of adherents to movements, rather than the usually unfair accounts as related by biased antagonists; the hope to find sources ever nearer to the date of any one event, these incite scholars to keep a watchful eye on manuscript collections, or on archaeological excavations. What, for example, would scholars not give for a copy of a pre-Masoretic Bible or for some of the controversial literature which flourished during the early Christian centuries?

Geniza in Cairo. Such considerations have led all interested men of learning to regard the discovery of the Geniza in Cairo as something epochal. It is true that the depository in the Synagogue of Ezra the Scribe was known before 1897. In 1864, for example, the Jewish traveler Jacob Saphir paid a visit there, but as a result of the thick layers of dust which chokes everyone who enters there, as well as the poor condition of his eyes, he declared, too hastily, that very little of value was contained in the collection which was worth much trouble looking for. Saphir's disparaging appraisal notwithstanding, people began, a number of years afterwards, to help themselves to the contents of the Geniza, usually for the

purpose of selling them. In connection with the "raids" there was no doubt a great deal of fraud, as regards both the date and place of the various MSS. which were being offered for sale. Through these earlier visits a number of privately owned as well as library collections of Geniza fragments were built up. Most important among them are those in Oxford, the British Museum and the Jewish Theological Seminary of America, formerly owned by E. N. Adler of London, England.

Nevertheless, the lion's share fell to Cambridge University with which Dr. Solomon Schechter was connected at the time. In 1896 Mrs. Lewis and Mrs. Gibson, sisters, both interested in Oriental and more particularly Syriac studies, brought with them from the Orient a MS. which they had procured in Palestine. On examining it, Dr. Schechter recognized it to be a fragment of a Hebrew version of Ecclesiasticus by Jesus, son of Sirach or, as he is usually called, Ben-Sira. The work, regarded as apocryphal (literally, hidden; indeed in Hebrew the Apocrypha are called *genuzim*) had found no ardent admirers or protectors among the Jews since it was not included in the Canonical Scriptures. Although its epigrams are sometimes cited in the Talmud, generally in the Aramaic version, it was apparently not sufficiently valued by the Jewish people and was therefore permitted, or perhaps even aided, to fall into desuetude. Had it not been for the Christian Church which included the "hidden" books in its Canon, the apocryphal literature would have probably perished in its entirety. To Schechter, and later to all scholars who agreed with him that the fragments contained the original Hebrew version, this identification was nothing short of magnificent. He therefore left for Cairo at the end of that year, with the approval and assistance of the university, and obtained with the aid of Lord Cromer, British Resident in Egypt, a grant from the authorities of the Synagogue, for a handsome consideration, of course, which had to be renewed more than once, to search through the Geniza and take whatever he liked. Despite the fact that Schechter exerted care to take only MS. material he succeeded in finding about 100,000 items, according to his own estimate, all of which he deposited in the Cambridge Library.

This hoard of manuscripts, generally known as the Taylor-Schechter collection, still awaits cataloguing in the main, as do a good many others. Most libraries with a large Jewish section now possess Geniza fragments, obtained in one way or another. It is no facile task to identify the bulk of the items, usually extant in a fragmentary, dilapidated state, many of them hardly legible. The painstaking effort which is required to perform this task proficiently is apparent in every page of the *Catalogue of Genizah Fragments in Philadelphia*, prepared by the late Dr. Halper, 1924. But there is no doubt that every effort in this direction will be amply rewarded.

New Light on Jewish Life. Judging by essential contributions which have already been published

in large numbers, one may confidently assert that all phases of Jewish life, all fields of literary activity have been, and will be immeasurably enriched as more of the material is brought to light. Sacred and secular works alike found their way to the Geniza in the Cairo Synagogue and all of them already do, or soon will, help considerably to shed new light on almost forgotten events in Jewish history, to clarify the internal life in the Jewish communities during certain periods, to elucidate problems in literature or religion, to bring to life forgotten, or little known, authors, to reclaim for us lost works of celebrated leaders in letters and thought. Of the Hebrew Ben-Sira some two-thirds has thus far been discovered among the fragments. The extant portions were published by Schechter and several other scholars. Schechter also edited another MS. which he entitled *Fragments of a Zadokite Work*, believing it to be the official constitution of a Sadducee Group. The Geniza contains numerous Biblical MSS., all of them thus far post-Masoretic, yet not altogether devoid of critical or at least paleographic importance. It is rich in Talmudic and Midrashic literature, presenting variants, unknown fragments, commentaries, etc. The Palestinian Talmud, of inferior standing in Jewish religious life, and consequently neglected, has been particularly benefited by the discoveries among the Geniza fragments.

Of especial value to Jewish history and letters is that portion of the Geniza which is of the Gaonic and post-Gaonic period, roughly from about 750-1200. Egypt, as part of the Oriental Moslem World, possessed a large Jewish settlement whose members led an active life, communicating frequently with the communities in other countries. A period of several centuries which hitherto seemed to be surprisingly deficient in literary productivity and baffled scholars all the more because it should have been one of intense life is being illumined very rapidly. Schechter, Elbogen, Ginzberg, Davidson, Malter, Halper, Mann and others have all published source material which is invaluable for shedding light on this previously obscure period. Gaonic responsa, polemical writings, civil and religious documents, liturgical and secular poetry are again reappearing after centuries of silence. Nor can we overlook the Judeo-Arabic material which numbers about 12,000 items. They disclose to us the interest of the Jews not only in the religious life but in sciences. Astronomy, astrology, geography, history, medicine, mathematics and calendar calculations are all well represented among them. Although they do not attract the interest which the specifically Jewish writings do, their importance from many angles cannot be overestimated. A word must also be said about the palimpsests found in the Geniza, that is, MSS. in which a later writing was written over an earlier erased text. The most notable contributions in this field are the fragments of Aquila's translation of the Bible into Greek.

Unfortunately many publications of the Geniza material are scattered among periodicals and other miscel-

laneous volumes, making it difficult ordinarily to be fully informed of the rich crop which the Cairo Synagogue has so far yielded and will for many years continue to yield. R. G.

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GENOA, chief seaport of Italy, imposingly situated on the gulf of that name, an arm of the Mediterranean Sea, in lat. $44^{\circ} 25' N.$, long. $8^{\circ} 55' E.$ The city, built in the beginning on a narrow stretch of level ground along the sea, has spread upward into the foothills of the Ligurian Mountains. It was at one time a walled town with eight gates and to-day is strongly fortified. It has old churches, splendid Renaissance palaces and fine works of art. Of special note are the churches of Santissima Annunziata del Vastato and Santa Maria di Carignano, also the Palazzo Rosso and Palazzo Bianco. The Campo Santo, the cemetery outside the city, is one of Genoa's famous sights. In the Middle Ages Genoa was a leading commercial and maritime center, although the community was torn by internal strife and almost constantly at war with rival cities, notably Pisa and Venice. The university was established in 1471. According to general belief, CHRISTOPHER COLUMBUS was born in Genoa, either in 1446 or 1451. The modern port, whose harbor can accommodate the largest vessels, serves as the chief trade outlet for the agricultural and industrial products of northern Italy, and also exports much Swiss goods. Among the imports are coal, cotton and machinery. There is a large passenger traffic with North and South America and the Orient. Genoa has shipbuilding yards for naval and mercantile vessels, tanneries, cement works and textile mills. Pop. 1931, 608,096.

GENOA, CITY STATE, or the Republic of Genoa, was formed by the Genoese in the 10th century and existed until about 1800. In common with other Italian communes the Genoese wrested their charter of liberties from their prince in the 11th century and tested their strength with the Saracens. Genoa now emerged as a great maritime and commercial power and eagerly seized on every opportunity to enlarge the carrying trade that it carried on between Western Europe and the East. It founded Genoese trading colonies along the seaports of the Spanish and Barbary coasts and established Genoese fortresses along the shores of the Black Sea and on the banks of the Euphrates. The expulsion of the Moslems from Sardinia and the consequent acquisition of that island aroused the jealousy of the two formidable city republics of Venice and Pisa, and the story of the next two centuries is a pitiful tale of internecine conflicts between these sister republics for commercial and naval supremacy. The Pisans sustained a decisive defeat from the Genoese in 1284; but after successive German, Neapolitan and Milanese domination Genoa gained an effective independence once more in 1339. The Genoese now asserted themselves once more and administered a stinging defeat on the Venetians at

Chioggia in 1380. Yet once more Genoa weakened and fell under the power of France and of the Visconti of Milan until in 1528 it regained its independence and its republican form of government.

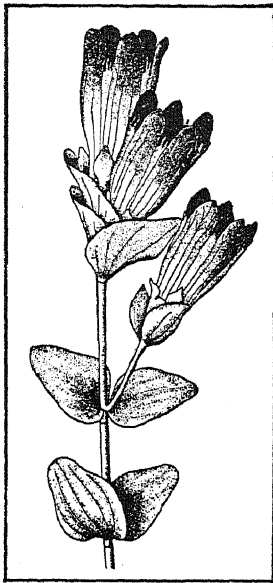
For almost three centuries thereafter it was practically free from foreign domination. The Napoleonic campaigns in Italy in 1796 terminated this independence, and in 1797 Genoa became a part of the LIGURIAN REPUBLIC and then of the French empire. In the settlements subsequent to the Napoleonic wars the Genoese republic became a part of the Kingdom of Savoy, and with it was incorporated in the newly constituted kingdom of Italy in 1861. It was from Genoa that GIUSEPPE GARIBALDI and his Red Shirts sailed in 1860 for the conquest of Naples and Sicily.

GENOA CONFERENCE, Apr. 10-May 19, 1922, a meeting at Genoa of prime ministers and other delegates of 34 European states and British Dominions to clarify and adjust post-war relationships among them and to work out a basis for renewal of relations with Soviet Russia. It set up continuing commissions of finance, on economic questions, on politics and on transport. In the discussions the delegates endeavored to settle disputes dangerous to peace and to clear the way toward better cooperation and the restoration of friendly financial and trading relations. While it did not achieve definite results of importance it promoted better understanding among the powers.

GENRE PAINTING, the type of painting which takes its subjects from scenes of everyday life. It is a late development in the art of painting, its first hints being in the small and homely bits set in illuminated manuscripts in the late Middle Ages. Pieter Aertsen of Amsterdam (1507-1573) was one of the first of the genre painters, and the Italian "naturalist," Caravaggio (1569-1609), was an early master in this field. It was in the 17th century, at the great period of DUTCH PAINTING, that genre work really came into its own. It demanded from the artist the realism of acute observation, study and balance of detail and complete objectivity. JAN VERMEER of Delft (1632-1675) was one of the greatest of the genre masters. Jan Steen (1626-1679) did work with a Falstaffian humor, while Gerard Ter Borch (1617-1681) preferred an aristocratic and military background, and Pieter de Hooch (1632-1681) painted homely scenes with charm and sympathy. Gabriel Metsu, Nicholas Maes and Gerard Dou were other noted Dutch genre painters. Louis le Nain did similar work at about the same time in France, and the French colorist J. S. Chardin (1699-1779) was a somewhat later master, as was the Venetian Pietro Longhi (1702-1785) whose genre work was touched with satire. Although genre painting became popular in all countries, the Ryksmuseum at Amsterdam remains the richest place in the world to study this type of work at its best.

GENRO, the group of "Elder Statesmen" of Japan. At the time of the Restoration (1868) the men who came into control of the reorganized government all were comparatively young and substantially this same group remained in control for many years. In their

later years they, and other men who had served in important government posts and reached old age, came to be called Elder Statesmen or the *Genro*. This group has no constitutional place in the Japanese government, but on the recommendation of the Meiji Emperor before his death in 1912 they came to be consulted on all important policies. The only member of the *Genro* group still alive is Prince Saionji.



FROM JEPSON, MAN. FL. PLANTS CALIF., COPYRIGHT

MOUNTAIN GENTIAN
(*Gentiana calycosa*). A handsome species native from the Rocky Mountains westward

GENS, the name given by American anthropologists to a primitive kinship group which counts descent through the father. A gens consists of a man, his children, his sons' children, his sons' sons' children and so on in the male line. The descendants of daughters would not belong to the gens since they would count descent through their own fathers. Members of a primitive gens often consider it incest to marry within the group, even if the mates are remote cousins, but they have

no bar against marrying a first cousin born into another gens. The prohibition is not always so strong, and in some cases, does not hold at all. See also DESCENT; EXOGAMY.

GENSERIC. See GAI-SERIC.

GENTES, groups of free Roman families all claiming descent from a common ancestor and under a common *patria potestas*, further united by a common worship, name, burial, customs, and forming a political unity. The exact organization of the *gens* is unknown; and the origin and development of the plebeian *gentes* is also a disputed point, as the original ones seem to have evolved into the patricians.

GENTIAN, a numerous genus (*Gentiana*) of plants of the gentian family (*Gentianaceae*), mostly perennial herbs bearing brilliant blue or sometimes yellow flowers. There are about 400 species, found in every continent except Africa, chiefly in high regions. They are notably abundant in the Alps where they form a conspicuous fea-



FRINGED GENTIAN
Gentiana crinita

ture of the flora. Of these Alpine species the dwarf blue gentian (*G. acaule*) is the most beautiful. The root of the yellow gentian (*G. lutea*), also of Alpine Europe, yields a valuable tonic. In the United States some 40 species occur, widely distributed, but most numerous in the Rocky Mountains. The fringed gentian (*G. crinita*), with a conspicuously fringed blue corolla, is one of the most attractive wild flowers of eastern North America. The closed gentian (*G. Andrewsii*), of similar range, with bottle-shaped flowers, is sparingly cultivated. Numerous gentians are cultivated in Europe, especially in rock gardens.

GENTIAN VIOLET, a mixture generally of pentamethyl-pararosaniline and hexamethyl-pararosaniline chlorides. It consists of dark green powders, or greenish glistening pieces, having a metallic luster. When dissolved in alcohol or water, an intense coloration is produced. Gentian violet is closely related to crystal violet and methyl violet, all three of which are dyes. In medicine it has been used as an antiseptic, having selective action for certain bacteria.

GENTILE, GIOVANNI (1875-), Italian philosopher and critic, was born at Castelvetro, Sicily, May 30, 1875. Educated at Palermo, he collaborated with his teacher and friend Benedetto Croce, in founding the *Italian Journal of Philosophic Criticism*, their purpose being to apply the neo-idealistic philosophy to problems of life and literature. His many critical and philosophical works culminated in *Spirit and Pure Act*, 1916, which gave a systematic formulation to his philosophic "activism." He applied his idealistic "activism" to pedagogical theory, and was rewarded by the adoption of his system of pedagogical reform under the Fascist régime. The guiding principle of his system is his faith in the use of intelligence in solving problems.

GENUS, in taxonomy, a subdivision of the family and made up of species that show a close relationship. Since biologists do not in all cases agree as to the limitations of genera no exact definition can be given. The structural or phylogenetic relationship of the included species should be quite evident in a natural genus. A few examples may convey the generic concept better than definitions. The genus *Quercus* includes the oaks. There are many species but all agree in being woody plants with a peculiar fruit, the acorn, found in no other group of plants. The species of the genus *Rosa*, the roses, agree in being shrubs with flowers of a definite structure, urn-shaped calyx tube, five petals, numerous stamens and a "hip" fruit. Among animals the genus *Canis*, the dogs, include as species, the domestic dog, many wild dogs, the wolves and jackals, all evidently related. The genus *Equus*, the horses, includes the domestic horse, the ass, and the zebra. The species of a single genus can often be made to hybridize. Although species evidently belonging to the same genus can not in all cases be made to hybridize, yet the fact that two species hybridize is usually considered to be evidence that they belong to the same genus.

A. S. H.

GEOCENTRIC SYSTEM, or **PTOLEMAIC SYSTEM**, that conception of the universe which supposes the earth to be immobile in the center.

GEOCHEMISTRY, the application of the science of chemistry to various problems arising in **GEOLOGY**. The processes are studied whereby the chemical agents of the atmosphere, water and ground effect the chemical decomposition of rocks and of ore minerals. The chemistry of the formation of **DEPOSITS** of metals, coal, oil, salt, limestone and other minerals and rocks is investigated. In the case of igneous rocks, the techniques of physical chemistry must be used, because such high temperatures and pressures are involved. Geochemistry here merges with **GEOPHYSICS**, and in geophysical laboratories important chemical information is obtained on the formation of rock minerals, **IGNEOUS ROCKS** and **ORE DEPOSITS**, and investigations are made of the transformations they undergo during the process of **METAMORPHISM**. Studies of this kind have also been responsible for the development of the technique of making certain **GEM STONES** artificially, such as the **RUBY** and **SAPPHIRE**. See also **CHEMISTRY**; **WEATHERING**; **MINERALOGY**; **SEDIMENTARY ROCKS**; **PETROLOGY**.

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GEODE, a cavity in an **IGNEOUS** or **SEDIMENTARY** **ROCK** lined with mineral matter, often well crystallized. The cavity may be of minute to cave-like proportions. Geodes are sometimes found in boulders weathered out of softer rocks. Quartz crystals, amethyst, agate, opal, zeolites and calcite commonly form geode linings. See also **AMYGDULE**.

GEODESY, that branch of practical science which takes as its field the determination, by accurate surveying, of the dimensions, form and shape of the earth as well as of its detailed surface features.

GEOFFREY OF MONMOUTH (c. 1100-54), English bishop and chronicler, was born about 1100. His 12 volume *Historia Regum Britanniae*, which first appeared in 1139, marks a turning point in the history of European literature, for it was the source of the **ARTHURIAN LEGENDS**. Among possible sources for Geoffrey's work are the Latin Nennius and a book of Breton legends. Internal evidence would indicate that Geoffrey used his imagination and inventive genius on confused legends and early records of British history. **HOLINSHED** and other later historians treated the *Historia* as authentic history. Geoffrey died at Llandaff in 1154.

GEOFFROY SAINT-HILAIRE, ETIENNE (1772-1844), French naturalist, was born at Étampes, April 15, 1772. Trained for the church at the College of Navarre, Paris, he nevertheless decided upon science as a career and began the study of botany and medicine at the College de France and the Jardin des Plantes. In 1794 he was associated with G. C. **CUVIER** in work upon natural history, and four years later accompanied Napoleon to Egypt. He was elected a member of the Academie des Sciences, 1807, and thereafter devoted himself to the study of comparative

anatomy. His *Philosophie Anatomique*, begun in 1818, brought him into controversy with Cuvier; Geoffroy Saint-Hilaire, following J. von **GOETHE**, disputed the causal element generally placed in the scheme of organic development. He became blind in 1840, and died at Paris, June 19, 1844.

GEOGRAPHICAL SOCIETIES, scientific organizations whose activities are chiefly directed toward the compilation and distribution of accurate geographical knowledge. Among the many societies in existence to-day may be mentioned the National Geographical Society, at Washington, the American Geographical Society of New York, the Royal Geographical Society of London, the Royal Scottish Geographical Society, the Royal Geographical Society of Australasia, the Geographical Society of South Africa, the Royal Asiatic Society, the French Société de Géographie, the German Gesellschaft für Erdkunde, at Berlin, the Italian Geographical Society, at Rome, the Royal Geographical Society, at Madrid, Spain, and the Sociedad Argentina de Estudios Geográfica Gaea, at Buenos Aires.

GEOGRAPHY, in a broad sense, the scientific description of the surface features of the earth, especially in connection with the activities of man. It is one of the oldest sciences. As the peoples of the world have risen from savagery to civilization, they have become increasingly and more vitally interested in the earth as their field of activity. They have expanded the rude knowledge of their native land derived from intimate daily contact with soil and weather, natural vegetation, animal life, and other peoples in their circumscribed movements and enterprises to a widespread appreciative interest in all the lands of the earth.

The oldest traditions, the earliest sagas, the most ancient records of nearly all races are rich in geographic lore and allusion. The stages in the advance from casual, or superficial, local observations of primitive peoples, colored by gross superstition or imagination, to the rational, profound science which constitutes the geography of the cultured nations to-day, form a criterion by which the progress of civilization may almost be measured.

In the advance of geography to its present exactness and inclusiveness, it has given rise to a group of related, generally more restricted, sciences—geology, physiography, meteorology, hydrography, oceanography, anthropology, ethnology and in a measure botany and zoology, economics and sociology. Many minor divisions of natural science might well be included within this catalogue, more or less concerned with the earth itself, with man, or with man's occupancy of the earth. At times, geography has been most concerned with the earth; at times chiefly with man; at present almost wholly with man's relation or adaptation to his environment.

ANCIENT GEOGRAPHY

Ancient geography competed with astronomy for the attention of the seers and sages in the early civiliza-

tions from which the western European culture is remotely or directly derived. The high plateaus and sunswept slopes of the Pamirs, the open plains and star-painted, cloudless skies of Egypt, Judaea, Chaldea, and Assyria, nourished pastoral peoples whose chief interest lay in the brilliant display of the heavens forced upon their attention as they guarded their herds and flocks; the narrow, rocky, inhospitable coastal plains of Oman, Phoenicia, Greece, and Carthage harbored sea-faring peoples whose vision embraced distant shores and scenes and strange life of plant and beast and man. Among the latter, geography rose to prominent place; among the former, astronomy dominated the sciences. The Hebrews lived in a local circumscribed world of which Canaan was the center and Nubia and Greece on the west, Nineveh and Babylon on the east, the Black Sea on the north, and arms of the Indian ocean on the south, were the boundaries; the Phœnicians lived in a cosmopolitan world extending from Cornwall to Zanzibar, and from India to Scythia.

Previous to the period of colonization in Greece, geography played but a minor part in the knowledge of the Hellenes and associated peoples; but with the spread of colonization and the imperial extension of conquest, the Greeks became expert geographers; and a brilliant galaxy of men, antedating the Christian Era, well-traveled and well-schooled in the principles of geographic observation and interpretation, lighted the way to sound geographic science. To this group belong Thales of Miletus and Pythagoras who are both credited with first teaching the Greeks that the earth is a sphere; Anaximander, who first introduced maps into Greece; Hecataeus who wrote the first geographical description *Survey of the World*; Herodotus who traveled far and wide, wrote many geographical treatises, and narrates the tale of the circumnavigation of Africa by Phœnician explorers sent out by Necho, king of Egypt; Xenophon and his *Anabasis*, the thrilling account, rich in geography, of the adventures and exploits of the Immortal Ten Thousand; the geographers who accompanied Alexander's armies in their farflung conquests; the author of the *Periplus* of Scylax, a description of the geographic features from the Strait of Gibraltar along both coasts of the Mediterranean to the Black Sea; Pytheas who explored the southern shores of Britain, and the coast of northwestern Europe as far as the mouth of the Elbe and who explained the connection of the tides with the moon; Eratosthenes, who wrote three books on geography and made of the subject an exact science; Hipparchus who checked the maps and studies of Eratosthenes; and finally Strabo, who possessed the store of fact derived from his Greek predecessors augmented by the great wealth of geographic knowledge elicited by the extensive campaigns of imperial Rome, with which to elaborate the science.

Rome produced few geographers of note, despite her widespread dominions. Pomponius Mela, more a compiler and commentator than geographer; Pliny the Elder, who devoted three whole volumes, and

more, to largely second-hand material of geographic character; Cæsar, who, by his careful observations and adequate records, contributed much new material; and Agrippa, more a patron of geography than geographer himself; these four are practically all the geographers that Rome can boast, for Marinus of Tyre, and Ptolemy of Egypt, who ranked high in the science of geography in the Roman period, were not of Roman birth.

MEDIEVAL GEOGRAPHY

The early Christian period, the so-called Dark Ages, produced little geography, though it was marked by pilgrimages and crusades which were to supply the impetus for the great travels of the Columbian period to follow when the boundaries of the world were pushed far beyond the wildest imagination of the early Christian monks and scholars and crusaders. The period is characterized by violent attempts in the Christian lands to adjust geography strictly to the dicta of the Old Testament, while the Arabians were progressing far in advance of the peoples of western Europe. The Norse Vikings crossed the Atlantic by way of Iceland and Greenland to the middle latitudes along the coast of North America, but their records failed to become a vital part of the geographic record of the time. The proselyting missions of the Church carried Christianity afar, but did little to expand geographic knowledge. Marco Polo and his companions traversed the breadth of Asia and returned with a thrilling geographic account of their travels. Most of the maps of the period were based upon the theory of a flat world, fantastic as the arguments brought forth to support the theory. At the close of the period an improved system of navigation charts, the portolani, were accurate and satisfactory as far as sailing was concerned, without any regard to the flatness or sphericity of the world.

MODERN GEOGRAPHY

The modern era of geography, as of history, begins with the discoveries of Columbus, Vasco da Gama, Magellan, and their successors, when the world became round in the minds of the people, when the explorations of new lands beyond the seas stirred the imagination, and geography rose to new power and dignity in the affairs of the nations, and when the widespread use of the compass in navigation and of printing in communication extended the range of movement and the breadth of learning.

Expansion of Scope. Modern geography, like the geography of the ancients and of medieval times, has undergone great transformation, not by any catastrophic or abrupt development but by a steady progress toward the explanation and interpretation of the physical and biologic features of the earth and of the peoples and their activities upon it. Beginning with the exploration of the lands and seas themselves, their survey and mapping, out to the most remote and inaccessible corners, a phase of the science still proceeding actively with ever-increasing attention to ac-

curacy and detail; continuing through the similar study of the vegetation, the animal life, and the people that live upon the lands and seas; and engaged chiefly at present in the interpretation of the phenomena associated with all lands, and seas, and life, geography has taken first rank as a natural science. As distances are virtually reduced by improvements and refinements in the methods of transportation and communication, by highway, rail, steamer, and airplane, and by telegraph, telephone, and radio, the nations are drawn nearer in interest and understanding, and peoples become conscious of place and race as never before.

But as the science has progressed and expanded, the several branches or departments of knowledge with which it is naturally concerned, have become so extensive in material for investigation and study as to warrant their separation from the parent store into distinct sciences. Thus have arisen geology and oceanography, geomorphology and physiography, meteorology and climatology, pedology (the relatively recent science of soils), ecology and plant and animal geography, anthropology and demography, ethnology and ethnography, and in a sense, economics and sociology and their related fields. Yet geography has retained a certain interest in all these fields, the relation of the earth environment to human activities, or the adjustment of man to his physical and biologic milieu.

ADVANCE OF GEOGRAPHICAL SCIENCE

For a century or more the powerful nations of western Europe have accorded geography a prominent place in the curricula of their schools and higher institutions of learning.

Progress in British Empire. The English, engaged in exploring the vast colonies that they have acquired over the whole world, have been most intensely interested in surveying and mapping and studying the physical qualities of the lands that have come under their administration. The British point of view may perhaps be best presented by a few pertinent excerpts from the final chapter of *History of Geography*, issued in 1913 by J. Scott Keltie and O. J. R. Howarth, two British geographers who fairly represent the English attitude, as follows:

"The whole structure of geography rests upon two great pillars—upon exploration and upon measurement."

"As concerns the British Empire, it has been an unrealized ideal that a territory should be surveyed as soon as possible after occupation, and it was not until 1905 that the defects and lack of system in the mapping of British territories generally were sufficiently widely realized to cause the creation of a Colonial Survey Committee as a central advisory and supervisory body."

"Geomorphology, though not accepted without demur as a definite branch of science in itself, has at last come to be generally recognized as a convenient term to connote the study of terrestrial relief."

"We have already given sufficient indication that the exact scope of geography has not been found easy to define by common consent * * * the new value attaching to the geographical studies of distribution and environment makes it imperative to carry the story further. These studies have not only been systematized in themselves, but have become complementary of other sciences, and thus we find the term 'geography' incorporated in certain scientific compounds—zoogeography, or zoological distribution; anthropogeography, the distribution of mankind; biogeography, the distribution of living things generally—or perhaps more mercifully treated in such phrases as 'plant geography.' Zoogeography and plant geography are concerned with division of the earth's surface into regions possessing individual characteristics in regard to their fauna or flora. The principle of regional division, indeed, has become a leading principle of geographical research, in regard not only to fauna and flora, but to man as well; to the physical characters of the land, and to climatic conditions."

The British concept of geography is further indicated by the final sentences of one of the concluding paragraphs of that book: "The fostering of geography as an educational subject has been one of the great tasks, and that of furthering exploratory and other research another, of the many geographical societies which have been founded throughout the civilized world in the nineteenth century and after. That of Paris in 1825, and that of Berlin in 1827, are the oldest of these now flourishing, though with the Royal Geographical Society in London (1830) was merged the older African Association."

Progress in France. The French point of view, by which the primary emphasis in the field of geography is laid upon the distribution and character of man's activities and man's achievements as affected by the milieu, is probably most clearly suggested by an excerpt from a review by Douglas W. Johnson, a leading young American physiographer, in *The Geographical Review*, vol. 12, 1922, of *La Géographie de l'histoire* by Jean Brunhes and Camille Vallaux among the most prominent and representative of the contemporary French school of geographers:

"The interrelations of geography and history, lead naturally to the discussion of men as geographic agents. In modifying the surface of the earth the sixteen hundred millions of human beings continually active upon it are far more important, in the opinion of the authors, than are the physical agents of nature such as volcanoes, glaciers, and rivers. This because of the vast scope of man's activities, his remarkable adaptability to varying physical conditions, and the infinite variety and incalculable number of his acts which in their totality profoundly and ceaselessly affect land areas; and especially because, as Woeikof has accurately remarked, man has power over the *movable things* on the earth. He can control the moving waters, dam them, change them into other forms of power, lead them in canals to serve as means of transport or to irrigate his fields. Agriculture de-

depends on his control over the surface layers of the lands, his ability to break and move them, to remove some elements and add others. Road construction, house building, mining, manufacture involve the breaking in pieces and putting together again of the movable things on the earth. It is his power over these things which makes man of interest not only to the ethnographer, the historian, the statistician, but also to the geographer who sees in him the most important of all geographic agents."

Progress in Germany. The German attitude toward the science of geography as represented by Richtofen, Ritter, and Ratzel and a score of other brilliant geographers of the past century, is not so sharply and clearly defined by their numerous successors of this century, though the dominance of the influence of geographic environment still remains the keynote of German geographic philosophy. Not placing almost sole emphasis upon the physical background and upon phenomena of distribution as the British seem to have done, nor laying the major emphasis upon man's activities and achievements as the French seem to have done, the Germans have correlated more closely the interactions of lands and people, making interpretation their major concern. A quotation from the *Influences of Geographic Environment*, by Ellen Churchill Semple, dean of American geographers, who studied in Germany as a disciple of the German master, Ratzel, probably the greatest geographer of all time, reveals the general German idea:

"Man can no more be scientifically studied apart from the ground which he tills, or the lands over which he travels, or the seas over which he trades, than polar bear or desert cactus can be understood apart from its habitat. Man's relations to his environment are infinitely more numerous and complex than those of the most highly organized plant or animal. So complex are they that they constitute a legitimate and necessary object of special study. The investigation which they receive in anthropology, ethnology, sociology and history is piecemeal and partial, limited as to the race, cultural development, epoch, country or variety of geographic conditions taken into account. Hence all these sciences, together with history so far as history undertakes to explain the causes of events, fail to reach a satisfactory solution of their problems largely because the geographic factor which enters into them all has not been thoroughly analyzed. Man has been so noisy about the way he has 'conquered Nature,' and Nature has been so silent in her persistent influence over man, that the geographic factor in the equation of human development has been overlooked.

"In every problem of history there are two main factors, variously stated as heredity and environment, man and his geographic conditions, the internal forces of race and the external forces of habitat. Now the geographic element in the long history of human development has been operating strongly and operating persistently. Herein lies its importance. It is a

stable force. It never sleeps. This natural environment, this physical basis of history, is for all intents and purposes immutable in comparison with the other factor in the problem—shifting, plastic, progressive, retrogressive man."

Progress in Other European Countries. Holland, Sweden, and Switzerland for a century or more have been most actively concerned with economic geography and demography. Because their congested populations have pressed closely upon their meager resources and limited area, these lands have offered problems for their geographers that have demanded early solution. Poland, Hungary, Belgium, and Finland, have likewise encountered these problems and encouraged their geographers to work toward their solution. In Italy, Spain, and the rest of the Mediterranean lands, geography in its modern aspects is just beginning to take hold.

Progress in America. America has long been backward in the development of her geography. Geology, geomorphology, anthropology, and half a score of other sciences, originally derived from geography, have made much faster progress and contributed much more aid to the practical phases of the economy and politics of the country. Only since the World War has there been a general awakening to the importance of the science, and the need for its inspiration and cultural stimulus in the secondary schools, the colleges, and the universities.

The trend in American geography would be hard to define. Physiography and geomorphology for 20 years or more prior to the World War preempted the attention of the geographers. Economic geography has gained an increasingly prominent place, particularly since the World War. Regional geography engrosses the attention of many of the foremost American geographers as the second quarter of the 20th century opens. The human geography of the contemporary French school and the anthropogeography of the German school, as expressed in Ellen Churchill Semple's *Influences of Geographic Environment*, are without doubt powerfully affecting the direction of the current of American geography, in research, in scientific literature, and in secondary school textbooks. The foremost universities of the land are initiating departments of geography or expanding those already organized. The University of Chicago has for a quarter of a century emphasized the field of geography as a major university science. The Clark Graduate School of Geography at Worcester, Mass., has for 10 years maintained a staff of specialists engaged chiefly in research and graduate instruction. The universities of Wisconsin, Michigan, California, and Ohio State, and Columbia University have long recognized the importance of geographic training and built up strong staffs. Harvard, Yale, and Princeton are developing the subject, and many smaller institutions are doing creditable work in the science. Numerous teachers' colleges and normal schools are featuring preparation and training for teaching geography.

The textbooks in the common schools of the land

have been immeasurably improved in factual content, illustrations and maps, and interest since 1920. *The Geographical Review*, without doubt the best example in the world of professional geographic magazine; the *National Geographic Magazine*, popular monthly serial that has done more to popularize geography than all other agencies; *Economic Geography*, concerned with the best utilization and conservation of resources, and with industry of all kinds; the *Journal of Geography*, devoted to the interest of geography teachers; the *Bulletin of the Geographical Society of Philadelphia*, a worthy example of local publication in the field; and the newly established *Home Geographic Monthly*, for children; these six constitute the leading American publications in the field. Rapid progress characterizes the development of geography in America at present.

VALUE OF GEOGRAPHICAL KNOWLEDGE

The need for a full knowledge of the natural resources of the world, and a better understanding of the natural conditions to which man must more carefully adapt himself as population increases and the burden upon the land is made heavier, has only recently made itself felt; it is from this need that the new interest in geography has sprung.

Man is living in a highly industrialized world; the relationships between his resources, their wise utilization, and the common weal, are intricate and devious. His conquest of Nature seems more nearly complete than ever, yet in ever increasing measure, Nature's influences become the decisive factors in limiting his activities.

He is vitally concerned with the tillable and arable soils; with the forests, the grasslands, the deserts; with the food and fiber-producing plants, the fisheries, the animal life, both feral and domestic; with the metallic ores, the oils, and the fuels; with water power, and routes of trade and travel. As a citizen of the modern commonwealth he is prepared to act intelligently on the larger problems of national and international economic and social relationships only when he appreciates the possibilities and limitations of the habitable portions of the earth.

The study of geography should lead to a better understanding and a more intelligent sympathy between the various peoples of the world, and, while stimulating patriotism should not encourage selfish nationalism. The peoples of the world must learn to work together, to use the world's resources for the common good, to rise together to higher planes of comfort and culture; to achieve this cooperation they must become fully acquainted with each other, must recognize each other's strength and weakness. Only geography can supply them the necessary knowledge.

W. E. E.

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History of Geography, 1913; Jean Brunhes and Camille Vallaux, *La Géographie de l'Histoire*, 1921; J. Russell Smith, *North America*, 1925; Clarence F. Jones, *South America*, 1930; W. O. Blanchard and S. S. Visher, *Economic History of Europe*, 1931; L. Dudley Stamp, *Asia*, 1929; Griffith Taylor, *Australia*, 1911; A. C. Haddon, *The Races of Man*, 1925; Wm. Z. Ripley, *The Races of Europe*, 1899.

GEOGRAPHY, LINGUISTIC, study of the geographical distribution, grouping and delimitation of linguistic phenomena, whether by detailed discussion or by maps. Its methods are applicable to practically every phenomenon of language, and it serves as a valuable check against too sweeping generalizations. Historically, by examination especially of place-names, it often aids in determining the extent of territory occupied by peoples in prehistoric times; practically it may help in tracing boundaries for states and provinces; and scientifically it may yield valuable linguistic material through comparison of maps for different periods of the same area or for (at least apparently) identical phenomena found in different areas. Linguistic maps are given in increasing numbers in scientific studies of language, whether general or specific; and linguistic atlases already exist, either complete or in various stages of completion, for France, Daco-Rumania, Denmark, Switzerland and North Italy, Catalonia, Brittany and other areas, and one is projected for the United States and Canada.

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GEOID, the name given to the surface of the EARTH as determined from actual observations of sea level. It is slightly irregular in shape but does not deviate more than 300 feet at any point from a smooth, and true, spheroid.

GEOLOGICAL SOCIETIES. In many countries geologists have organized to promote research and further the publication of discoveries in earth science. The oldest such body is apparently the Geological Society of London, founded 1807. To the 1830's date back the Geological Society of France, the Geological Society of Edinburgh, and the Royal Geologists of Ireland. The German Geological Society was founded in 1848; the societies of Belgium and Italy were established a decade or two later.

In America, the earliest geological organization was a local one, the Wyoming Historical and Geological Society of Wilkesbarre, Pa., which maintains a library and museum devoted to the Wyoming Valley. Among the more important societies of the United States are the Geological Society of America (1888), Geological Society of Washington (1893), Society of Economic Geologists (1920) and the California Geological Society. There are also state geological societies, and important organizations devoted to paleontological and mineralogical research.

GEOLOGIST, a scientist engaged in studying and teaching earth history as recorded in rock formations of the past and illustrated in physical processes of the present. With increasing interest in mineral resources many geologists have been employed in gov-

ernment surveys and in mining enterprises, and now with the rise of the petroleum industry a large proportion of geologists are specialized employees of oil companies, engaged in a search for ANTICLINES.

R. S. P.

BIBLIOGRAPHY.—T. C. Chamberlin and R. D. Salisbury, *College Text-book of Geology*, 1909; C. K. Leith, *Economic Aspects of Geology*, 1921.

GEOLOGY, the science of the earth, the aim of which is to investigate the globe whereon man lives, how it came into being, of what it is composed, what forces mold its form and appearance, what unfamiliar aspects it may once have worn, and to follow the story of the EVOLUTION of its living denizens and their forebears. From a knowledge of the results produced by forces now acting on the earth, it is possible to gain an understanding of the many changes which have taken place in the thousands of million years the planet has existed.

The science of the earth has so many aspects that all other natural sciences become involved in it at some point. The great overlap between geology and biology is covered by PALEONTOLOGY, wherein is studied the evolution of life. Chemistry enters into the investigation of the origin, alteration and decay of rocks and the formation of soils. Special phases of this type of study are sometimes grouped under the heading GEOCHEMISTRY. So potent an aid has physics proven in solving problems of the earth's aspect and constitution that an almost independent science, GEOPHYSICS, has come into being. Geophysics has proven valuable also in working out problems of local geology and locating hidden mineral resources. In the study of the origin of the earth, geology merges into cosmology, which is itself a branch of astronomy.

Geology treats comprehensively of the earth as a subject of study and research, so that a number of branches of the science have come to be recognized as separate fields of study, and are grouped as the geological sciences. A general knowledge of at least their fundamentals is prerequisite to an adequate comprehension of geology. Principal among them may be mentioned:

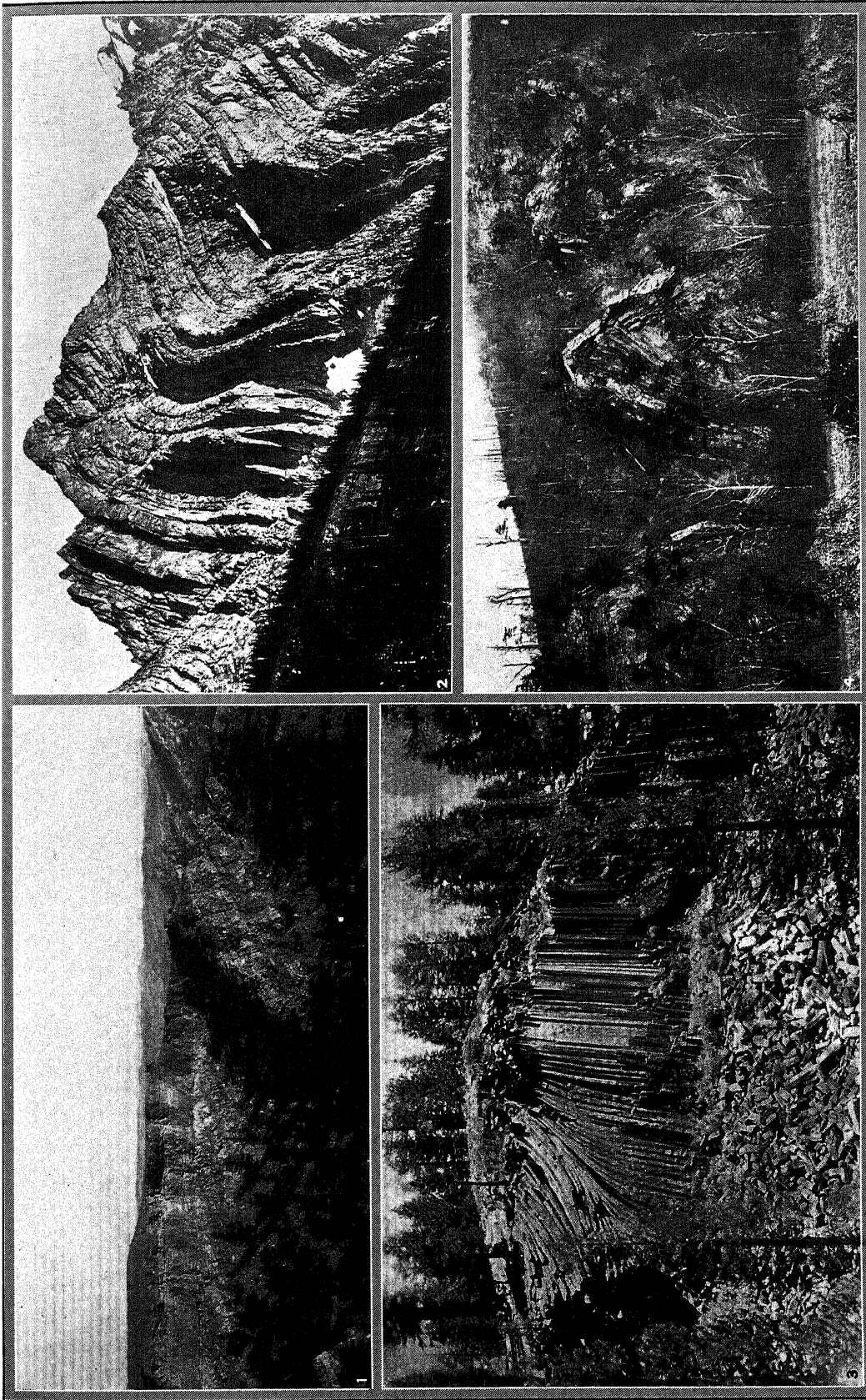
MINERALOGY, which deals with the origin, composition, alterations and properties of minerals, the inorganic chemical compounds formed naturally in the earth. The study of the geometrical forms, or crystals, in which they are found, and of the properties peculiar to this state, is the province of CRYSTALLOGRAPHY. Rocks are generally formed of a more or less definite aggregate of minerals, and the study of rock masses, their origin, their relations to each other and of their component parts, belongs in the field of PETROLOGY. The economic uses to which rocks and minerals may be put, and the study of the origins and compositions of MINERAL DEPOSITS and ORE DEPOSITS, are comprised in the science of economic geology. **PHYSIOGRAPHY** deals with the present surface of the earth, how it attained its present expression, and the forces which act to modify it. The life of past ages,

and its evolution, as revealed in the fossils entombed in the rocks, are studied in the science of paleontology. The various phenomena peculiar to the oceans and to the atmosphere are respectively the fields of investigation of Hydrology and METEOROLOGY.

Geology studies the mass of materials of which the earth is composed, to determine their origins and natures; it investigates the forces acting upon them to modify their compositions and arrangements, and considers the character and extent of the results thus produced. Consequently, there are three main subdivisions of geology. Dynamical Geology is concerned with the various agents and forces, such as wind, water, ice, VULCANISM and dislocations of the earth's crust, which operate to modify the outer portion of the globe. Structural geology deals with the nature, positions, structure or "architecture" of the component rock masses which make up the outer shell of the earth. These two parts of geology are classed together as physical geology, as opposed to historical geology which reviews the sequence of past events, the character and extent of former modifications of the earth's crust, as revealed in the rocks and fossils. This second main division includes paleontology, already mentioned, and paleogeography, or the geography of the lands and seas in former geological ages. An understanding of the forces acting on the globe is prerequisite to a comprehension of its present, or previous, structures, and of the changes which the earth has suffered in ages past.

Origin of the Earth. Until the early years of the 20th century, the nebular hypothesis put forward by the Frenchman, P. S. LA PLACE, was supposed to give an adequate explanation of the origin of our solar system. Promulgated in the closing years of the 18th century, it postulated a whirling globe of incandescent gas whose diameter was approximately equal to that of the orbit of the outermost planet. As this mass cooled and contracted, rings were thrown off occasionally which ultimately condensed into small globes which passed through stages, first of hot gas, then molten liquid, and finally the smaller ones attained the stage of solid planets.

Subjected to critical examination by physicists and geologists during the present century, the nebular hypothesis was found wanting. T. C. CHAMBERLIN and F. R. Moulton, of the University of Chicago, then put forward their planetesimal hypothesis which pictures the sun as a highly eruptive body which shot forth a bolt of material possibly under the influence of a passing star. This material cooled into solid particles which gathered into knots by their own gravitational attraction. The name "planetesimal" was given these particles, and the earth is supposed to have been built up by their infall, and was therefore always solid. The Englishman, SIR JAMES JEANS, proposed an alternate theory which, modified by Harold Jeffreys, his countryman, is known as the tidal disruptive theory. In this, the bolt of material is supposed to have been drawn from the sun largely as the result of the near passage of a large star. While still



1, 3, 4, COURTESY UNITED STATES GEOLOGICAL SURVEY; 2, R. A. DALY, ESQ.

TYPICAL FORMATIONS OF IGNEOUS AND SEDIMENTARY ROCKS

1. Strata in the Bighorn Basin, Wyoming, which have been tilted and then eroded to a nearly horizontal plane. On this a new series of rocks were laid down horizontally, the plane of separation between the two series constituting an unconformity. 2. Folded strata of Heavens Peak, Montana, from which weathering and erosion have carved imposing mountains. 3. Typical columnar jointing in basalt, due to contraction while cooling. Devils Postpile National Monument, California. 4. Anticlines and synclines in limestone of Silurian age along the Great Cacapon River in West Virginia.

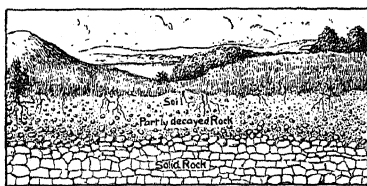
gaseous, this collected into knots and formed balls of incandescent gas. Thus the earth was originally a globe of hot gas which quickly cooled, first to a molten globe at which stage a part was whirled off and became the moon, and then to the solid mass inhabited to-day. From the formation of the sphere of gas to the solid earth may have occupied only 15,000 years.

The crust which finally formed on the solidifying earth was so re-worked, cut through by upwelling molten material and then buried so deeply beneath later sediments that it has never yet been recognized.

During the liquid stage the heavier materials had a chance to gravitate toward the center of the globe, resulting in a greater density for the earth as a whole (5.55) than for the surface rocks (2.77). Geophysical data indicate a core, or BARYSPHERE, about 2,200 miles in radius which is non-solid, inelastic and probably highly superheated, and may be largely metallic. Surrounding this is a rocky envelope, or LITHOSPHERE, divided into STEREOSPHERE, ASTHENOSPHERE and surface "zone of fracture," which grades from predominantly PERIDOTITE mixed with core material, through BASALT to the surface which is typically GRANITE.

With the acquisition of a solid crust, there came into play the opposing sets of forces which tend, on the one hand, to destroy the surface relief of the globe, and on the other to build it up.

The rocks of the earth's crust are continually being acted on by WEATHERING and EROSION, which break them down and eventually wash them toward the seas. Chemicals in the atmosphere, rain and soil, and the mechanical action of falling and flowing water, the prying action of freezing water, disintegrate and decompose the rocks, eventually to form soil. In



FROM SCHUCHERT AND LEVENE, THE EARTH AND ITS RHYTHMS, COURTESY D. APPLETON & CO.

CHANGE, THROUGH WEATHERING, FROM
SOLID ROCK TO SOIL
After Tarr

arid regions, wind-borne sand abrades exposed rock surfaces. The particles of rock and soil thus formed are washed down slope and downstream, the running water using them as grinding material which further wears down its channel. Soluble materials are carried off in solution. Thus the high lands are carved into mountains and valleys, and the mountains themselves may be reduced eventually to the level of the river plain. Continued long enough, the result would be a flat, swampy plain, traversed by sluggish streams, known as a PENEPLAIN.

Most of the load of dissolved salts and suspended particles is eventually dropped. Some of the salts go

to enrich the salt content of the ocean, some are precipitated, and marine organisms use some for their shells and skeletons. The transported particles are dropped as the water loses velocity. These processes of SEDIMENTATION form DEPOSITS of such materials as SAND, CLAY, CALCITE and GYPSUM. The SEDIMENTARY ROCKS, such as SHALE and LIMESTONE, result from the compaction of these various types of deposits. Wind, and ice in the form of glaciers, are also responsible for some small sedimentary deposits.

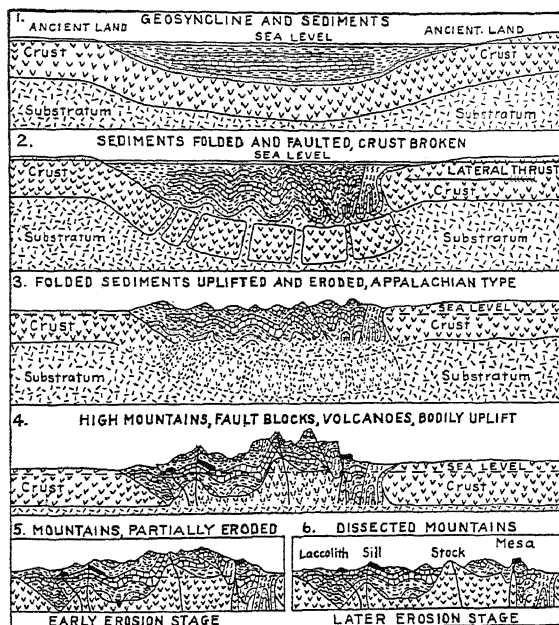
The study of the sedimentary or stratified rocks in their relations to each other is the province of the science of STRATIGRAPHY.

Although the final result of erosion and weathering is not entirely one of destruction, since new rocks are formed, the OCEAN encroaches on the land, the action of waves and current being to carry away shore material and push the strand line farther and farther over what was land. Thus the various formations underlying what was once a continent are covered by new material deposited in the encroaching seas. The plane of separation between the two different series is called an UNCONFORMITY, and gives proof that their periods of deposition were separated by an interval of erosion. Were there no rejuvenating action, the continents would thus become eventually nothing but shoals beneath the waters of a universal ocean.

Until recently it was thought that the upbuilding of the lands was due to the crumpling of the earth's crust as the interior cooled and shrank, much as the skin wrinkles on a drying apple. This idea is being replaced by that of isostasy, which pictures the continents, formed of lighter, granitic rocks, as practically floating on a substratum of heavier, plastic, basaltic rock, like icebergs in the ocean. The wearing down of higher lands and the resulting deposition elsewhere of the material thus obtained, upsets the balance of "floating" continents to restore which the lands bend and warp, sinking in places and rising in others. In the process the oceans oscillate back and forth, flooding part of the continent and covering it with sedimentary rocks, which later may become dry land as the seas are rolled back in some new movement.

Occasionally these up and down, or epeirogenic movements are accompanied by intense horizontal thrusts, or orogenic movements, which crumple the rocks into great folds, much as one would crumple a pile of papers by pushing the ends together. The rocks bend, crush and break, and pile up to form such mountain ranges as the Appalachians and the Alps. The rock masses are traversed by cracks, along which movement may take place, producing faults. A hardly perceptible movement on such a fault is sufficient to produce a powerful earthquake tremor, and such tremors may be the only evidence man has that mountain-building is in progress, for the movements themselves are inconceivably slow. The study of the causes, locations and characteristics of earth tremors is the special province of SEISMOLOGY.

Crustal disturbance, or "diastrophism," of the kinds described is not infrequently accompanied by the various phenomena of **VULCANISM**, such as the formation of volcanoes, and the upwelling of a molten **MAGMA**



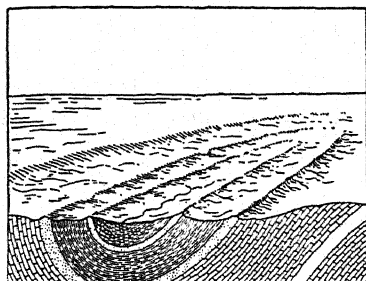
COURTESY AMER. MUS. OF NATL. HISTORY

STAGES IN THE EVOLUTION OF MOUNTAINS
Drawing by Chester A. Reeds

which solidifies into **IGNEOUS ROCKS**. The formation of **ORE DEPOSITS** is sometimes an accompaniment of vulcanism.

Through the action of vulcanism, movements in the earth's crust, circulating solutions and vapors, and weight of overlying sediments, the igneous and sedimentary rocks may be altered more or less completely, producing the third great class of rocks, the **METAMORPHIC ROCKS**.

Structural Geology. Evidently, it is through the processes above described that the structure of the

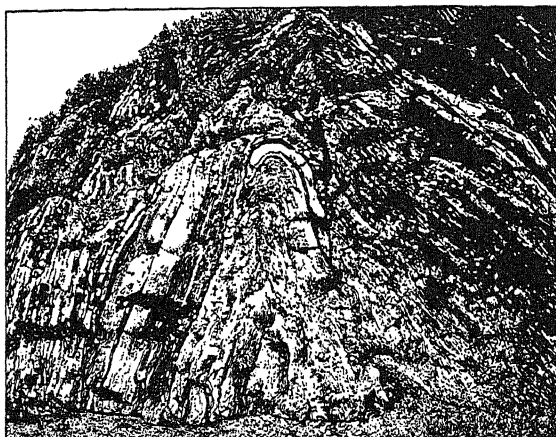


FROM WILLIS. GEOLOGIC STRUCTURES.
MCGRAW-HILL BOOK CO.

SYNCLINE SHOWING THE OUTCROP ON
THE SURFACE AND A VERTICAL CROSS-
SECTION

earth is made, and is continually being altered. The sedimentary rocks are normally laid down in approximately horizontal layers, beds or strata. The structures of the strata themselves are related to the con-

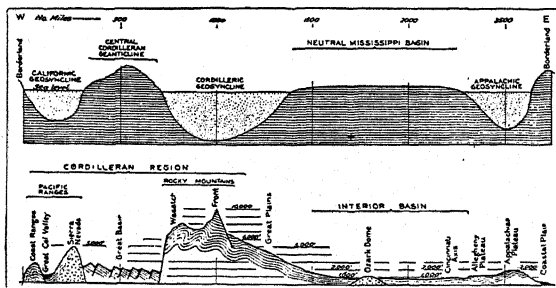
ditions under which they were deposited. The coarser the material the more turbulent or swiftly flowing was the water which laid it down. Irregularly disposed beds, or "cross-bedding," usually mean river or wind-blown deposits. In a similar manner the structures of igneous rocks indicate the conditions under which they cooled, the larger, more slowly cooled masses showing the coarser crystals. Igneous rocks are char-



COURTESY AMER. MUS. OF NATL. HISTORY

ANTICLINAL STRUCTURE SHOWING SHARP FOLDING

acteristically found in rather irregular bodies, whereas the sedimentary ones except where tilted and deformed later, are more or less flat and regular. The intrusions of igneous rocks into sedimentary beds may cut across them, or the strata may be uplifted into domes or arches. If near the surface, or exposed by later erosion, such bodies often form hills or mountains, due to the greater resistance of the igneous rocks to weathering and erosion.

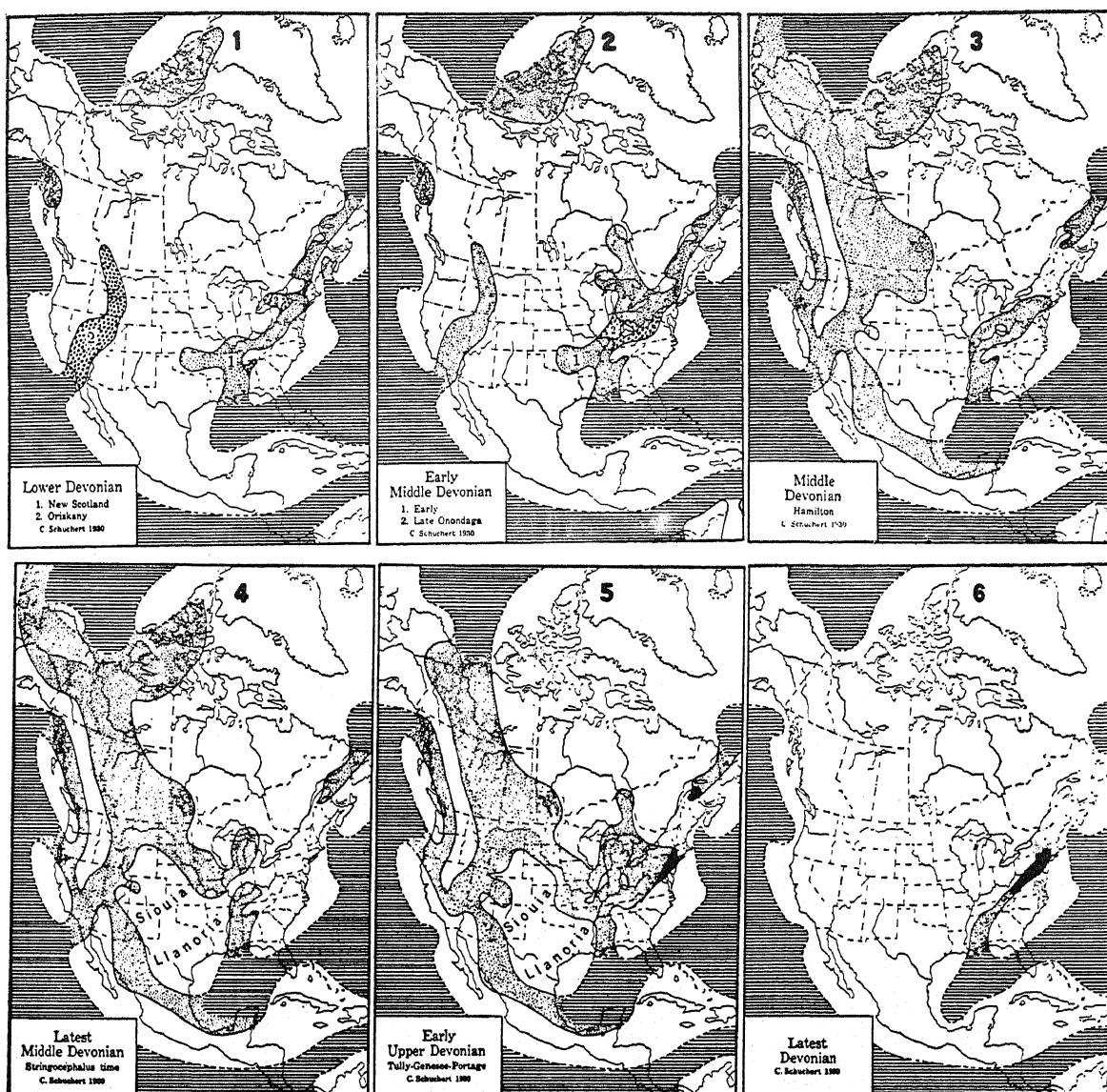


FROM CHARLES SCHUCHERT, OUTLINES OF HISTORICAL GEOLOGY, JOHN WILEY & SONS

GENERALIZED DIAGRAM TO ILLUSTRATE THE GENERAL STRUCTURAL RELATIONS OF THE LITHOSPHERE IN SECTION ACROSS THE UNITED STATES

Above, the places of the ancient geosynclines, geanticlines, and borderlands before the making of the mountain ranges. Below, the present geologic structure. (Vertical scale much exaggerated)

Mountain ranges are built when the earth's crust is deformed, either by uplift or by folding, or both, often accompanied by igneous intrusions. The uplifted type, resulting from a lifting and tilting of blocks of the earth's crust, are often called "block mountains." Uplifted blocks may be sculptured into flat-topped mesas and buttes or, if tilted, into parallel



COURTESY CHARLES SCHUCHERT, OUTLINES OF HISTORICAL GEOLOGY, JOHN WILEY & SONS

PALEOGEOGRAPHY OF DEVONIAN TIME

Epi-continental seas dotted; oceans ruled; volcanic regions indicated by crosses; deltas in black. The Devonian Period is one of the best illustrations of a diastrophic cycle, occurring between the Caledonian mountain building of western Europe and the Acadian mountain making of eastern North America. Note the progressive but very slow spread of the oceans from the four quarters over North America until they unite to make one of the several largest floodings. The waters from the Arctic and Pacific brought Asiatic faunas (see maps 3, 4, 5); those from the Atlantic spread European ones in part, though in the main the eastern faunas were American in development. Note the first appearance of the Mexican geosyncline (map 3), and the persistent lands Siouia and Llanoria

ranges of peaks, illustrations being found in the ranges of the Great Basin region of western United States. The Appalachians and Alps are of the type produced by a compression and folding of portions of the crust. Where the rocks are bowed up into arches, the structure is called an **ANTICLINE**, and where bent downward into a trough-like shape, a **SYNCLINE**. Folded mountains are made up of series of anticlines and synclines which weather into a succession of parallel ridges.

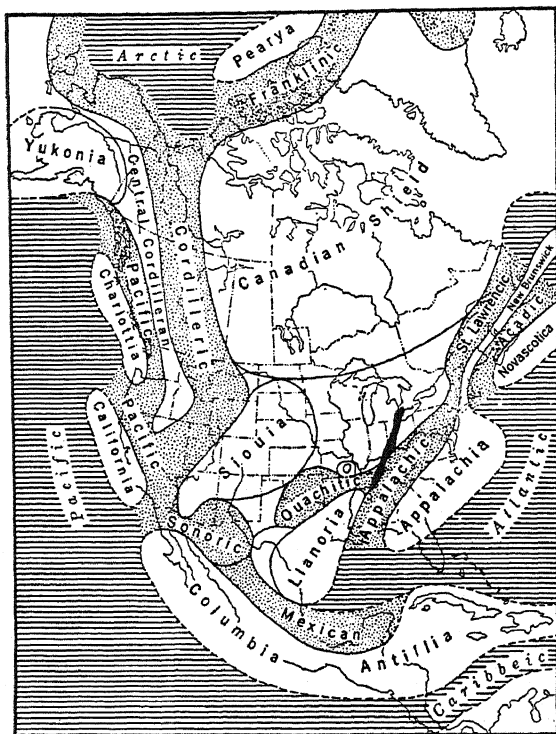
A particularly favorable location for the folding and pushing up of new mountain ranges occurs where

a great band of the earth's crust, possibly 100 miles or more broad and several times as long, has been progressively down-warped and filled with sediments, sometimes thousands of feet thick. Such a structure, called a **GEOSYNCLINE**, usually found between strong land masses, presents a zone easily folded and crushed. The materials of which the Appalachians were built were accumulated in a geosyncline, and the present Lake Superior may be such a structure.

In addition to the faults which accompany mountain-building and other earth movements, the rocks are often traversed by cracks along which no move-

ment has taken place, called **JOINTS**. They are usually arranged in rectangular patterns, and provide an easy access for surface waters, thus facilitating the weathering of the rocks they intersect.

The structure of a region has a profound influence on its topography. The relationship of mountain-building in this connection has been brought out. Where sedimentary beds still lie nearly flat, and hardly disturbed, flat, usually fertile plains are produced, as in central United States. The joint system may control the development of the drainage pattern, and the topography resulting from erosion will be influenced by the relative positions of rocks easily eroded



FROM CHARLES SCHUCHERT, OUTLINES OF HISTORICAL GEOLOGY, JOHN WILEY & SONS

LANDS AND GEOSYNCLINES DURING MIDDLE PALEOZOIC TIME

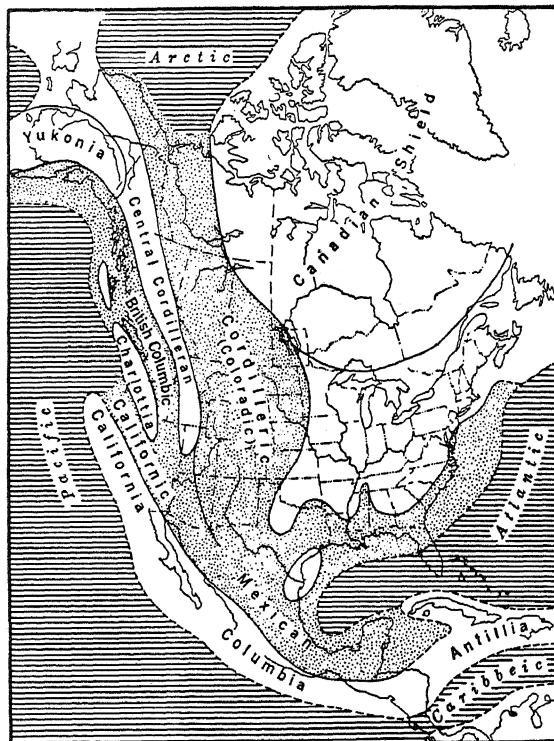
The North American borderlands (California, Charlottia, Columbia, Appalachia, and Novascotia) and geosynclines (Pacific, Cordilleric, Sonoric-Ouachitic, Mexican, Appalachian-St. Lawrenceic, and Acadic) during Silurian and Devonian times. In the west is the Central Cordilleran, in the east the New Brunswick, and in Ohio and Cincinnati (black) geanticlines. O = Ozark dome. Other lands are the Canadian Shield, Pearya, Yukonia, Siouia, Llanoria, and Antillia. Also note the Caribbean mediterranean

and those resistant to erosion. Such features as mountain barriers and navigable streams, which so profoundly affect the world's communication and commerce, are dependent primarily on the structure and geological history of the region.

Historical Geology. The crust of the earth has ever been in a continual state of change, the exterior forces of sun, wind, rain and ice conspiring to tear down the land, while the forces acting from within, probably born of the great stores of heat energy inside the earth's highly heated interior, intermittently build it up again. In the long history of the earth, five great Eras are marked off, the **ARCHEOZOIC**,

PROTEROZOIC, **PALEOZOIC**, **MESOZOIC** and **CENOZOIC** eras, during which erosion was reducing the elevation of the land toward a peneplain, and local warpings permitted the spread of shallow seas over the land, called epi-continental seas. The sedimentary rocks deposited in those seas entomb the **Fossil** remains which now show the kinds of life that flourished then.

The distribution and nature of the sediments and enclosed fossils provide evidence as to the ancient arrangements of land and water, and the conditions influencing the life of the times. Variations of life-forms, as recorded in the fossils, show the gradual evolution of types of life in certain districts, and



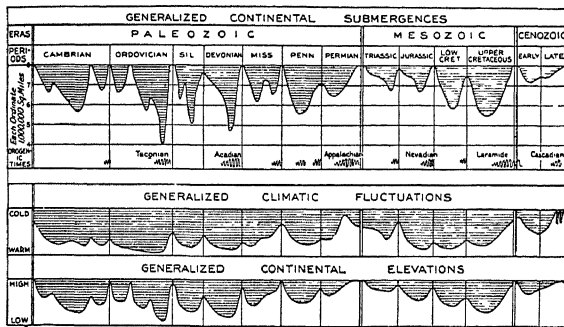
FROM CHARLES SCHUCHERT, OUTLINES OF HISTORICAL GEOLOGY, JOHN WILEY & SONS

LANDS (white) AND GEOSYNCLINES (dotted) DURING MESOZOIC TIME

the migrations of plants and animals from place to place. From these data it becomes possible to deduce the distribution of ancient land masses, as the continents often had shapes unknown on modern maps, land connections or bridges existed where now there is only water, and continents now joined were at times separated. Some geologists go so far as to adopt the theories of the late Alfred Wegener, according to whom the land of the earth was originally in one mass which split up into fragments and drifted apart to form the present-day continents.

The plants and animals of former times also provide clues to the climates which existed when they lived. The rate of evolution, the **CLIMATE**, and the surface features of the earth seem to be intimately related. During the long periods when the continents were well worn down the climates were

equable, and evolution proceeded slowly. The periods were separated, however, by intervals of crustal deformation, uplift of continents, and upthrusting of mountain ranges, and at times like these the climates tended to be dry, cool, and divided into temperature zones, as at present. Under the stress of such circumstances, evolution proceeded more rapidly. In fact, so cold did the climate become at places and during various times that GLACIATION and ICE AGES



FROM CHARLES SCHUCHERT, OUTLINES OF HISTORICAL GEOLOGY, JOHN WILEY & SONS

TIMES OF CONTINENTAL FLOODING

Diagram to show the times and extent in millions of square miles of continental flooding (white areas proportional to lands out of water); the times of mountain making; and the degree of continental elevation and climatic fluctuation

are recorded by the deposits in some rocks of all the eras.

The question of the age of the earth is one concerning which many unscientific estimates have been made, these varying from a few thousand years to infinity. The most reliable are now based on measurements of the radioactive contents of the oldest rocks, and indicate an age for the earth of between one and two thousand million years. Nearly half this

ERAS	PERIODS	MOUNTAIN-MAKING EPISODES	LIFE	YEARS B.C.
CENOZOIC	QUATERNARY	(THE GREAT ICE AGE)	AGE OF MAN	23,000
	RECENT			
	PLEISTOCENE			2,000,000
	PLIOCENE			
	MIOCENE		AGE OF MAMMALS	35,000,000
MESOZOIC	CRETACEOUS	ROCKY MOUNTAINS		60,000,000
	JURASSIC	SIERRA NEVADA		
	TRIASSIC	APPALACHIANS	AGE OF REPTILES	205,000,000
	CARBONIFEROUS			300,000,000
	PERMIAN			
PALEOZOIC	PENNSYLVANIAN	SCOTTISH HIGHLANDS	AGE OF FISHES	430,000,000
	MISSISSIPPIAN			
	DEVONIAN			
	SILURIAN			
	ORDOVICIAN		AGE OF INVERTEBRATES	500,000,000
PROTEROZOIC	CAMBRIAN			
ARCHEOZOIC		YOUNGER LAURENTIANS		800,000,000
		OLDER LAURENTIANS		1,200,000,000

FROM KIRTLEY MATHER, SONS OF THE EARTH, W. W. NORTON & CO.

THE GEOLOGIST'S TIME TABLE

time had run its course before plants or animals had developed structures sufficiently resistant to permit fossilization. The duration of man's existence is but one tenth of one per cent, or less, of the earth's history.

History of Geology. Geology as a science is comparatively new, for although the Greeks and Romans had some sound ideas on fossils, and the oscillations of land and sea, the Christian eras, down to the middle of the 19th century, were under the spell of the

story in Genesis. All rocks were supposed to have been formed by the Deluge, and fossils were "Sports of Nature," or animals drowned in the Deluge, or abortive attempts at creation on the part of Satan. Earthquakes and other "cataclysms" accounted for such features as hills and valleys.

The Frenchmen, J. B. LAMARCK, N. Desmarest, and J. E. Guettard, and the Englishmen James Hutton and John Playfair expounded many sound ideas on the origin and development of land forms, and the rôle played by erosion therein. Their labors, about the closing years of the 18th century, were ignored until the middle of the 19th, when reestablished by SIR CHARLES LYELL in England and JAMES D. DANA in America. Lyell's great contribution was the thesis that the forces now operating on and within the earth are the same that have always thus operated. Later J. W. Powell and W. M. Davis, in the United States, did fine work in the analysis of land forms. The idea of continental glaciation was developed by LOUIS AGASSIZ in the middle of the 19th century, in the face of much opposition.

The true rôle of fossils in the rocks was recognized by Leonardo da Vinci in the 15th century, Fracastro and Bernard Palissy in the 16th, and Nicolas Steno in the 17th, but still the idea persisted into the 19th century that fossils were the remains of animals destroyed by the catastrophe of the flood. Lamarck held this idea at first, but later abandoned it; he is really the father of the evolutionary school, although Lamarck's work was ignored until Charles Darwin's labors finally established its truth. The value of fossils in determining the sequence of sedimentary strata was discovered by WILLIAM (STRATA) SMITH early in the 19th century, in England, and he is honored with the title of the "Father of Stratigraphy." In America James Hall later did pioneer work in this field.

The classification of rocks on the basis of their mineral composition was attempted first by A. G. Werner, at Freiburg, late in the 18th century. K. C. Von Leonhard's treatise shortly afterward is credited with being the first consistent treatise on systematic rock classification. With the invention of the polarizing prism by William Nicol about 1828, the way was opened for exhaustive microscopic study of the rocks. The labors of Bischof, Bunsen and Senft in Europe, and of Pirsson, Iddings, Cross, Washington and Clarke in America, have done much to clarify and soundly establish the science of petrology.

S. F. K.

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GEOMETRICAL OPTICS, a subject treating of the methods of locating the path of the light from a

source. It relates to REFLECTION and REFRACTION from plane surfaces and from curved surfaces. The treatment may be by the wave-front method or the ray method. The former is the better for giving a physical picture of what is occurring; the latter is more suitable for actually constructing images, and it is the one to be used here. The discussion is confined

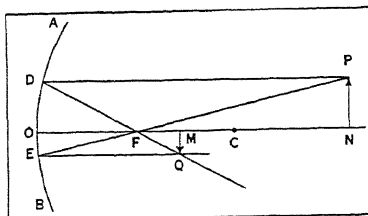


FIG. 1

MQ is the real and inverted image of PN

to MIRRORS and LENSES whose faces are spherical, and small apertures will be assumed. The study of spherical mirrors and lenses is the basis of all work on optical instruments.

From the spherical mirror, *AB*, concave in Fig. 1 and convex in Fig. 2, and with centers of curvature at *C*, take a radial line, *OC*, as the axis. Light coming

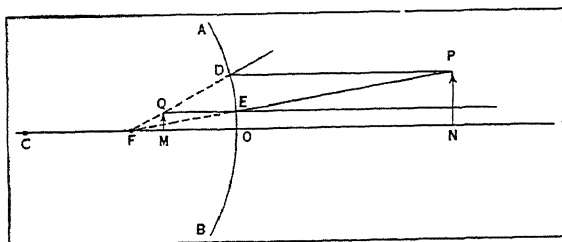


FIG. 2

QM is the virtual and erect image of PN

from a remote point and parallel to the axis will come, or seem to come, to a focus at *F* half way between *C* and *O*. This is called the *principal focus*, and *OF*, half the radius, is called the *focal length*. Light emanating from *F* in Fig. 1, or converging to *F* in Fig. 2, will, upon reflection, give a beam parallel to *OC*. The image of an object, *PN*, may now be

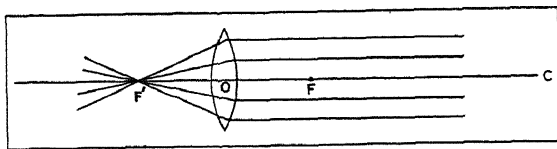


FIG. 3

Light parallel to OC converges at F

readily located, for a ray, *PD*, parallel to *OC* will, on reflection, pass through the principal focus, or appear to come from it, and a ray, *PE*, through *F* will become parallel to *OC*. Where the two intersect at *Q* is the point where all other rays from *P* falling on the mirror will focus. Two points related as *P* and *Q* are called *conjugate focal points*. Treating other points of *PN* in the same manner, it is seen that the size of the

image is to the size of the object as the image distance, *OM*, is to the object distance, *ON*. For Fig. 1, the image is *real* and *inverted*; for Fig. 2, it is *virtual* and *erect*.

A similar construction applies to lenses. Let *OC* be the principal axis. Light parallel to *OC* from a remote point to the right of *O* will, in Fig. 3, converge to a focus at *F'*, and, in Fig. 4, it will diverge as though it came from *F'*.

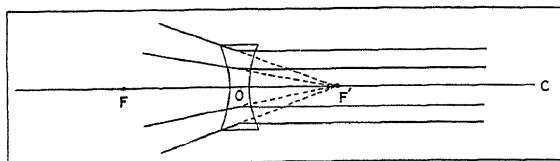


FIG. 4

Light parallel to OC diverges, appearing to come from F'

F and *F'* are called the principal foci, and *OF* and *OF'* the focal lengths. *OF* will depend on the radius of curvature of the surfaces and on the index of refraction of the glass. For an object, *PN*, a ray parallel to *ON* will pass through, or appear to come from, the principal focus. A ray through *O* is undeviated. The rays in Fig. 5 intersect at *Q* and it can be shown that all other rays from *P* come to a focus at *Q*. Two

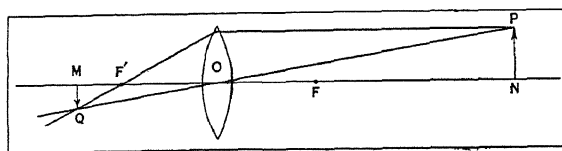


FIG. 5

QM is the real and inverted image of PN

points related as *P* and *Q* are called *conjugate foci*. Treating other points on *PN* in the same manner, the image, *QM*, is obtained. The image is real and inverted. In Fig. 6 the rays diverge, but, to an observer to the left of the lens, they seem to come from *Q*, and a virtual erect image is thus formed. In both cases, the image size is to the object size as the image distance from *O* is to the object distance.

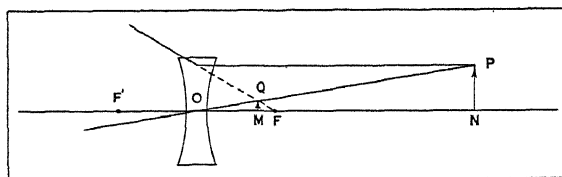


FIG. 6

Light rays diverge on passing through the lens and seem to come from Q

For both mirrors and lenses, the position of the image can be calculated from the relation $1/u + 1/v = 1/f$, where *u* is the object distance, *v* the image distance and *f* the focal length. For convex mirrors and concave lenses, *f* must be taken negative.

The simple treatment above holds only in the assumption that the thickness of the lenses is negligible.

When this is not true, the subject becomes more complex but may still be quite completely solved. The assumption is also made that the sizes of the lenses and object are small compared to the distances used.

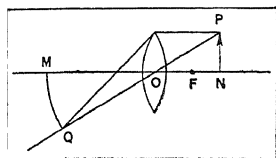


FIG. 7

A curved image, MQ , is produced when the distance between the lens and object is small

Various other defects arise (see CHROMATIC ABERRATION and SPHERICAL ABERRATION), but it is possible to quite largely correct each of them.

One of the most important optical instruments is the simple MICROSCOPE, which is a convex lens with the object nearer than the focal point, as in Fig. 8.

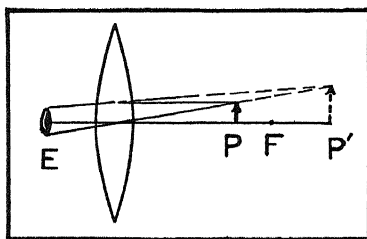


FIG. 8

Geometrical construction shows the image to be virtual, erect and magnified. An observer adjusts the lens to such a position that the image is at the distance of vision, i.e., from 10 to 12 in. from the eye.

In TELESCOPES and compound microscopes, an objective is used to form a real image, as in Fig. 5, and this image is then viewed by a microscope as in Fig. 8. P. I. W.

GEOMETRIC STYLE, the term applied to the first half of the Decorated Period of English Gothic window tracery. The earliest tracery consisted of circles, trefoils, etc., pierced through the thin wall over the arched heads of adjoining windows. Such tracery is called plate tracery, and from it the Geometric style in this first period is sometimes called Perforated, or Plate Gothic. Bar tracery was a natural development from plate tracery and allowed much freedom in geometric design. The period is also characterized by rich carved ornament, and intermediate ribs began to be introduced on the vaulting. The period may be dated as covering the second half of the 13th century. See TRACERY and for bibliography GOTHIC ARCHITECTURE.

GEOMETRY. As the word indicates (Greek *ge*, earth, + *metron*, measure), it originally meant earth-measure, surveying, and possibly geodesy. Indeed, in certain parts of Europe a surveyor is still called a geometer. Long ago, however, the name was generally applied to the science of forms, and especially

to the demonstrating of propositions. Although this phase of geometry probably occupied the attention of the Egyptians and Babylonians before the Greeks entered the field, we have no definite records of any attempt at logical proofs before the time of THALES (c. 560 B.C.). His greatest pupil, PYTHAGORAS, developed the science still farther, and for three centuries after his death (c. 501 B.C.) geometry was the center of mathematical interest among the Greeks. The greatest textbook on elementary geometry was written by EUCLID about 300 B.C., at the Greek city of Alexandria, in Egypt. In the century following, the greatest of the Greek works on any phase of higher geometry was written by APOLLONIUS (c. 225 B.C.). This was upon CONIC SECTIONS. After that time pure geometry made not very distinctive advance until the 17th century, when Desargues (1639) wrote a work in which he laid the foundations of a certain phase of the modern treatment of the subject. PROJECTIVE GEOMETRY was developed largely by Poncelet (1822) and later by such German scholars as Gauss, Möbius, von Staudt, Plücker and Riemann, all in the first half of the 18th century.

Foundations. The demonstration of any proposition is effected by making use, in a logical way, of one or more propositions already proved or assumed. That is, we say that if *A* has been proved, and if *A* implies *B*, then *B* is proved. But manifestly the first proposition cannot be proved by any preceding one, because none precedes it. Therefore certain propositions must be assumed as true. These are usually called postulates (from the Latin *postulare*, to demand, that which the teacher demands the pupil to grant without proof, as a first step). Such an assumption is that we may draw a straight line from any point to any point. The Greeks also took as part of the foundation certain common opinions, or notions, now usually known as axioms, such as, the whole is greater than the part. They sought to assume as few postulates and axioms as possible and then to see how elaborate a structure could be logically built upon these foundations. The greatest of the Greek writers on elementary geometry, Euclid, seems to have given five axioms and five postulates, there being some variations in the manuscripts of his works.

Euclid also limited the instruments that could be used, these being the compasses and an unmarked ruler or straight-edge. Many constructions, such as the trisection of any given angle, are easily effected if we allow other instruments; but cannot, as can be proved by higher mathematics, be effected with the two that he allowed. When we say, for example, that no one can square a circle (see MENSURATION; CIRCLE; *PI*), we simply mean that the impossibility has been mathematically demonstrated when only the compasses and the unmarked ruler are allowed to be used. (See AXIOMS; POSTULATES.)

Branches. Geometry has various branches. Euclidean geometry is that branch which assumes the postulates and axioms that Euclid stated and recognizes the

limitation of the compasses and the unmarked ruler. Euclid uses other postulates than those which he lays down; for example, he assumes that if an unlimited straight line cuts a circle in one point it will cut it in one and only one other point, and also that a figure may be moved about in space without any change in space or size.

Non-Euclidean geometry assumes that one or more of Euclid's axioms or postulates is false, as, indeed, they are under certain conditions. It lays down a series of postulates and axioms differing from his and upon these it constructs a perfectly logical geometry. This was done, for example, by the Russian mathematician Lobachevsky about 1823-30, and independently by Bolyai, a young Hungarian scholar, about 1823-32. Euclid had postulated that through a given point only one line can be drawn parallel to a given line, although not precisely in these words. Lobachevsky and Bolyai postulated that more than one could be drawn. The result of this leads to the proof that the sum of the angles of a triangle is less than 180° , which is the case in certain types of space.

Euclid's axiom, the whole is greater than the part, is also false if we are talking of infinite magnitudes. For example, consider the two series

$$\begin{array}{ll} S_1 & 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, \dots \infty \\ S_2 & 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, \dots \infty \end{array}$$

each term of S_2 is formed from the term above it in S_1 by multiplying by 2, and hence there are as many terms in S_2 as in S_1 ; that is, one of these infinities is equal, as to the number of terms, to the other. But S_2 is evidently only half of S_1 , being composed of every other term in the sequence. Hence the half of S_1 is equal to the whole of S_1 , considering each as an infinite sequence. Furthermore, if we consider a triangle as material, modern science shows us that it cannot be moved about in space without some sides being shortened in the process. Hence it is now said that Euclid's geometry is based upon assumptions that are substantially true in the limited space in which we work, or that they are true in Euclidean space, that is, in the space in which it is assumed that his axioms and postulates are true. If our space is curved through a fourth dimension (*see* DIMENSIONS; FOURTH DIMENSION), as the surface of sphere is curved through a third dimension, then our Euclidean geometry ceases to apply, becoming only approximately exact. There are various non-Euclidean geometries possible, depending on the postulates that we assume.

Analytic geometry uses equations to represent lines or surfaces, studying the equations instead of the forms themselves. This process is often the more simple and more productive of important results. It is particularly valuable in the study of conic sections and curves in general. (*See* CURVES.) Indeed, the old geometric way of studying such curves has been generally abandoned in favor of the analytic, or algebraic, method. (*See* ANALYTIC GEOMETRY.)

Extent of Euclidean Geometry. Euclid divided his great work on geometry into 13 books. Of these, Book I treats of the foundation principles, and of the nature of (1) triangles, (2) parallels, and (3) areas of triangles and parallelograms, including rectangles. Book II relates to geometric algebra as shown in such identities as (in modern form) $a(a+b) = a^2 + ab$ and $(a+b)^2 = a^2 + 2ab + b^2$. Having no algebraic symbols of any importance, the Greeks had recourse to geometry to state and prove such relations. Book III treats of circles as touching or cutting each other or a straight line, and of central and inscribed angles. Book IV relates to problems, showing how, by the unmarked ruler and the compasses, certain polygons can be inscribed in or circumscribed about a circle, or the reverse.

Book V considers ratio and proportion, giving a method which applies to incommensurable lines, corresponding to irrational numbers, as well as to commensurable ones, corresponding, as treated, to positive integers or fractions, a subject already studied by Eudoxus (c. 370 B.C.). In modern teaching this is usually treated by algebra, it being assumed in the presentation of the matter in elementary schools that all the terms are positive and rational numbers, and that all lines are commensurable. The Greeks were more thorough. Sir Thomas Heath has justly said, "Greek mathematics can boast no finer discovery than this theory, which first put on a sound footing so much of geometry as depended on the use of proportions." It is to be regretted that the Greek treatment is too difficult for pupils of the age of those who study elementary geometry in our schools.

Book VI applies the theory of proportion to the study of similar figures and to propositions related to them. This completes the plane geometry of Euclid as we ordinarily consider the subject. Books VII-X relate to matters now treated by algebra. Books XI-XIII treat of solid geometry, but seem to have been less carefully considered by Euclid than those relating to figures in a plane. Possibly this was because he saw that the training in logical proof was sufficiently covered in Books I-VI.

Euclid's great classic is the foundation upon which all modern textbooks are built. His language is dead, but his spirit lives. We omit his geometro-algebraic work, we change the order of his propositions, and we place the emphasis upon exercises rather than upon a book proof; but the idea of a logical framework exists, for without it we should have only the intuitive geometry of childhood. It would be possible to greatly extend the number of his propositions, but the tendency is rather to reduce it, leaving more time for exercises which shall give the pupil an opportunity for original thinking and for the play of his imagination.

Measurement. Euclid paid no attention to the measurement of figures except as he established the principles by which measurement is possible. When we measure in the usual way, a triangle, for example, we assume that we can find the exact length of two

lines. As a matter of fact this is impossible. We can assume it possible and state what the area would be if this assumption were correct, which is not the case. Similarly, we may assume that we can express the ratio of the circumference to the radius of a circle by means of a definite fraction, which is not the case, and then we can find the area, which can be done only approximately. All this was foreign to Euclid's ideals of precise logic and exact results. In our modern textbooks we pay much attention to measurement, leaving it for the pupil to find, later in his studies, that the results of all measurements, as expressed in numbers, are merely approximations. It is, however, entirely logical to say that if the side of a square were exactly 2 in., the area would be exactly 4 sq. in., even though we can never ascertain exactly the length of the side of any square, or even construct an exact square with any instrument, however precise it appears to be.

Terms. The terms used in geometry are sufficiently explained in any textbook on the subject to answer the reader's purposes. It should, however, be said that any precise definition of the most elementary terms is impossible for the reason that there are no terms more elementary with which to define them. Such terms include point, straight line, surface and angle. We really postulate the existence of such concepts and describe what we mean as best we can. For example, we describe parallel lines by saying that they are lines lying in the same plane and which will never meet, however far produced, and we assume that such lines exist. We then prove that straight lines perpendicular to the same line are parallel, although geodetic lines perpendicular to the equator meet at the two poles. We then say that geodetic lines are not straight, but if, as modern science tends to believe, our space is curved, then our parallels would resemble great circles on a sphere. All this merely suggests that we must constantly remember that the terms used in elementary plane geometry must be, in that domain, confined to Euclidean space and to figures in a single plane therein.

For a further discussion of the subject the reader is referred to the following topics in this encyclopedia: ANALYSIS, ANALYTIC GEOMETRY, CURVES, DIMENSIONS, DESCRIPTIVE GEOMETRY, DUPLICATION OF A CUBE, EUCLIDEAN GEOMETRY, FIGURE, INFINITY, LOCUS, LIMITS, MATHEMATICAL MODELS, MENSURATION, MEASURE, NON-EUCLIDEAN GEOMETRIES, PLANE FIGURES, PROJECTIVE GEOMETRY, PI, PROPORTION, RATIO, RIEMANNIAN GEOMETRY, SOLIDS, SURFACES, TRIANGLE, TRISECTION OF AN ANGLE. D. E. S.

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GEOPHYSICAL EXPLORATION. See EXPLORATION, GEOPHYSICAL; GEOPHYSICS.

GEOPHYSICS, the study of the physics of the earth, including speculations on its origin and fate, and investigations of its shape, constitution, age, and reaction to various forces. Data from so many sources are used in these researches that geophysics touches almost every other science at some point.

Hypotheses of the origin of the solar system and the earth's place therein, must be submitted to the rigorous analysis of astronomers and physicists. Thus the Laplacian nebular hypothesis has been supplanted by that of tidal disruption. In this direction, geophysics merges into COSMOGONY, astronomy, and astrophysics, (see ASTRONOMY) and on the other hand, leads to consideration of the earth's present condition and age, questions of vital importance in GEOLOGY.

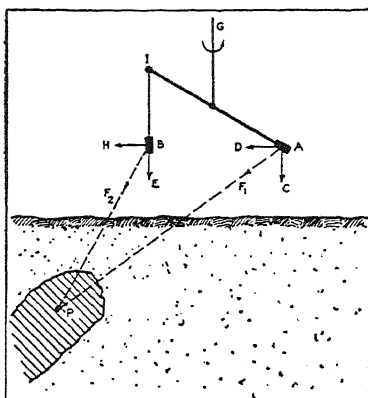
Estimates of the age of the earth have been made by various means, some utilizing geological data, such as the rate of formation of sedimentary rocks. The one most accepted at the moment is based on the relative proportions of uranium and lead in the oldest rocks of the ARCHEOZOIC formations, since the rate of radio-active transformation of URANIUM to LEAD is known. This method indicates an age of about 2,000 million years. About 15,000 years were probably required for the earth to solidify from a hot, gaseous mass, according to the tidal disruption hypothesis of Jeffreys.

Data on the shape of the earth are yielded by astronomy and by GEODESY, or science of earth measurement. This material is used by the geophysicist in his study of the forces that operate to give the earth its shape of a flattened, or oblate sphere. Involved in such studies is the question of the constitution of the globe's interior. Direct observation is impossible, but valuable evidence is obtained from a study of the transmission of earthquake waves, and of the tides in the body of the earth itself. These show that it is more rigid and more elastic than steel, and solid, except for the very core, which is nevertheless as rigid as the rest of the earth. The density of the earth as a whole is obtained from observations on its gravitational field, and is about four-fifths that of steel. Since the surface rocks are much lighter than this, the interior must be heavier than the outer shell. The core probably consists of iron, an hypothesis strengthened by the fact that meteorites are composed largely of this metal (see GRAVITATION, PHYSICS).

The behavior of elements and compounds within the earth can not be duplicated in the laboratory, since the pressures, in the neighborhood of 22,000 tons per sq. in. and the temperatures, around 50,000° C., are beyond laboratory range. Nevertheless, the study of compounds common in rock forming minerals is being pursued by the methods of physical chemistry, in which their stability, solubility, and freezing points are investigated under various temperatures and pressures. Mechanical, thermal, electrical, and optical properties of rocks and minerals are also studied under varying conditions.

The physical laws governing the circulation of the atmosphere and the ocean are of interest to the geo-

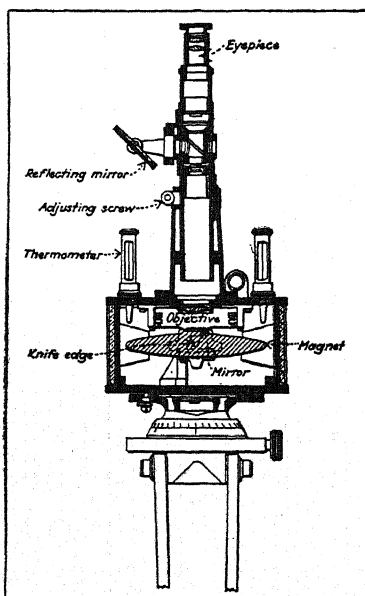
physicist, at which point he becomes interested in METEOROLOGY and OCEANOGRAPHY. With the geologist he studies: (1) ISOSTASY, or the balancing of light and heavy portions of the earth's crust, and the problems of the causes of the elevation and subsidence



SCHEMATIC DIAGRAM OF EÖTVÖS TORSION BALANCE ACTION

Heavy body at P attracts nearer weight B more than A, thus twisting torsion wire G

of parts of it, and its folding, distorting, and fracturing; (2) the mechanism of volcanic action, and its relation to crustal movements; (3) the chemistry and physics of the formation of ore bodies and rocks and minerals; (4) the earth's gravitational, magnetic, and



FROM ENGINEERING AND MINING JOURNAL-PRESS

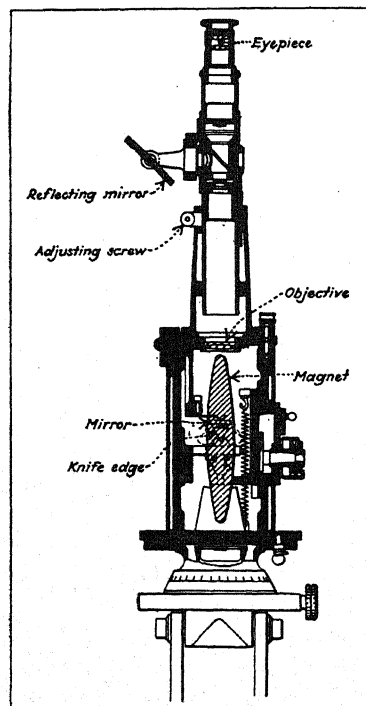
CROSS SECTION OF A VERTICAL MAGNETIC FIELD BALANCE, OR VARIOMETER

electrical fields and the causes of their variations; and, (5) methods of determining the geological inhomogeneities of the earth's crust. The latter problem leads directly to the art of applied geophysics.

Applied geophysics. The object of applied geophysics is to discover special or unique geological

bodies or discontinuities by the effects their physical properties produce on a field of force, either natural or artificial. The earth's gravitational field, for example, is affected by the densities of near-surface rocks, being stronger over the denser formations, and weaker over light ones. Most ore minerals have a specific gravity between 4 and 6, while igneous rocks range from 2.5 to 3, and the sedimentary ones are still lighter. Thus it may be possible to determine areas beneath which there is a change in the geological formations, by studying the variations in the gravitational field at the surface. This is accomplished by means of a torsion balance (see EÖTVÖS BALANCE) which measures differences in the strength of gravity with extreme delicacy. It consists of a bar suspended by a fine wire called torsion wire. This bar bears a weight at one end which is balanced by a weight suspended from the other end. The difference in direction and strength of the gravitational pull on these two weights produces a twisting of the torsion wire. This is registered photographically by means of a beam of light reflected by a mirror mounted on the wire.

Similarly, the magnetic field of the earth is affected by the constitution of the geological formations near the surface. Some minerals, as magnetite and pyr-

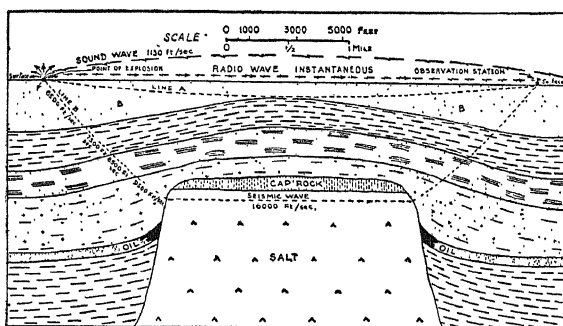


FROM ENGINEERING AND MINING JOURNAL-PRESS

CROSS SECTION OF A HORIZONTAL MAGNETIC FIELD BALANCE, OR VARIOMETER

rotite are "ferromagnetic," and may act like magnets themselves. Many rocks, especially the basic igneous ones, are paramagnetic (see MAGNETIC INDUCTION), that is, they increase the strength of the magnetic field where it passes through them. Others, such as rock salt and quartz, are diamagnetic, or decrease the

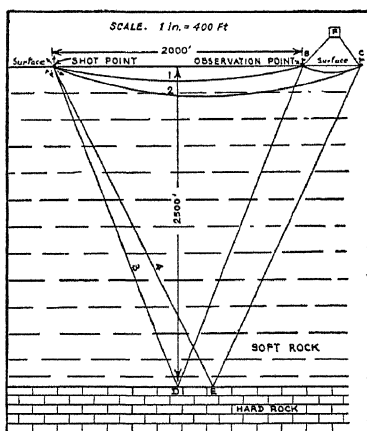
strength of that field. In studying the earth's magnetic field, its direction and intensity must be obtained. The direction of the field is given by a compass. For geophysical work, the variations in intensity are studied by means of a VARIOMETER. *See* MAGNETOMETER; TERRESTRIAL MAGNETISM. Vertical variometers measure the variations in vertical intensity by means of a magnetic needle normally lying horizontal, but mounted to swing in the vertical plane. Deviations from the horizontal position measure the vertical pull of the earth's field. Similarly, to measure the



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PATH OF REFRACTED EARTH WAVE THROUGH SALT DOME STRUCTURE

horizontal pull, or intensity, the needle is made to stand vertically. DIP NEEDLES are also used for rough work. Where geological formations differ in their magnetic effects, a study of the variations in the magnetic field may often be of help in mapping con-



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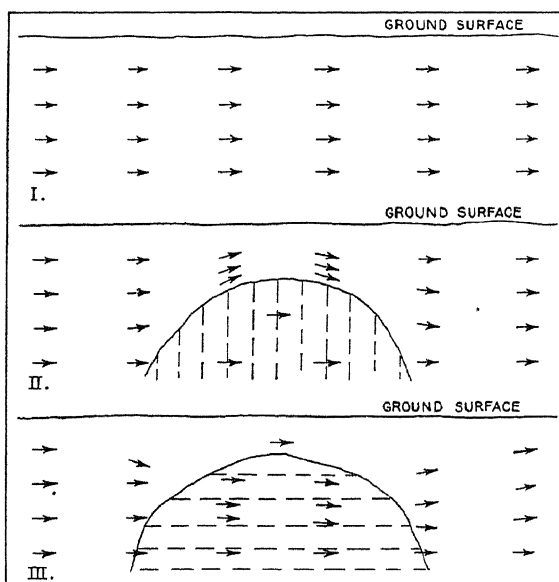
PATH OF EARTH WAVE REFLECTED FROM AN UNDERLYING HARD ROCK LAYER

cealed rock occurrences, and also in locating magnetic ores.

The above methods depend on measuring natural gravitational and magnetic fields of force for their data. An advantage is inherent in applying artificial fields, however, in that the geophysical explorer can vary their strength and position to suit his needs. Data of the earth's interior yielded by observation of earthquake waves, can be duplicated near the surface by setting off heavy charges of explosives, and record-

ing the times of arrivals of the resultant earth tremors at a number of temporary, portable SEISMOGRAPH stations, located within a radius of 10 or 20 miles. The speed of transmission of these waves through the rocks varies with the elasticities and densities of the formations traversed. The more compact rocks transmit them faster than do the loose formations, such as sand and clay. Consequently, points at which the speed of the waves changes, are indicative of a change in the rocks, and absolute speed of propagation is indicative of what kinds of rocks are involved.

The electrical method is the most convenient one of applying an external field. In this an electric current is passed through the ground, and either the curves of equal potential or the potential drops, are observed at the surface. The conductivities of the underlying formations affect the distribution of the electrical field at the surface, so that the presence underground of poor or good conductors may be deduced. Ore deposits are usually excellent conductors.



FLOW OF ELECTRIC CURRENT IN THE GROUND

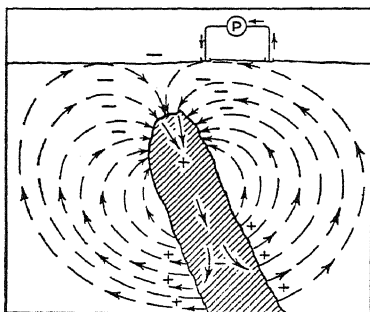
- I. In homogeneous ground there is an even distribution
- II. A resistant body causes some of the current to flow around it, concentrating a portion in the near-surface regions
- III. Most of the current flows through a conductive body, leaving an abnormally small amount near the surface

Rocks are not so good, but vary among themselves, the more compact, drier ones, such as granite and the metamorphic rocks, being poorer conductors than moist ones such as shale. Alternating current may be used to induce (*see* INDUCTION) a secondary current in underground conductors, such as ore bodies. The resultant electromagnetic field is measured, and its distortions from normal noted. These give information on the location, magnitude, and nature of the disturbing body.

These techniques are especially well adapted to making studies of geological structure and STRATIGRAPHY, and to prospecting for ORE DEPOSITS. Another phenomenon called "spontaneous polarization," in-

volving a natural electrical field, can also be used to locate bodies of sulphide minerals, such as chalcopryrite. These minerals, when undergoing oxidation near the surface, actually generate a feeble current of electricity which may be detected and measured at the surface. It is generally indicative of the presence of such minerals as PYRITE, CHALCOPYRITE and PYRRHOTITE.

Geophysical methods alone are not capable of telling just what kind of rock or mineral is indicated by



NATURAL ELECTRIC CURRENTS GENERATED IN SOME SULPHIDE ORE BODIES

Oxidation of the upper part of the body produces a flow of electric current as shown by the arrows. A measuring apparatus at the surface, such as a potentiometer P, is used to detect such currents

the data obtained, since they add only a few more physical data to those already investigated by the geologist. These methods must be looked on, then, as merely another aid to the geologist in his efforts to decipher the manner of occurrence of hidden geological formations. See also MINERALOGY; VOLCANISM; METAMORPHISM; PETROLOGY; GEOCHEMISTRY; SEISMOLOGY; MEGGER. S. F. K.

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GEORGE, ST. (d. 303), Christian martyr and patron saint of England, of whose birth and early life nothing is known. He was a native of Cappadocia and a military tribune under the Emperor Diocletian. Although his existence has been seriously doubted, he was honored in the Eastern church, but does not appear to have started his modern legendary career until the time of the Crusades. St. George was reported to have helped the Normans against the Saracens under the walls of Antioch in 1089, and was chosen by Robert, son of William the Conqueror, as the patron of the Norman crusaders. In the 14th century, the recently created Order of the Garter was made, under Edward III, an order of Knighthood, of which St. George was the principal patron, and the chapel of St. George in Windsor Castle was built as its official sanctuary. Many leg-

ends became associated with St. George in the Middle Ages, the most notable being his conquest of the dragon, which symbolized the devil, in order to deliver the king's daughter, who symbolized the Church.



ST. GEORGE KILLING THE DRAGON
By Albrecht Dürer

Raphael's famous painting is the best known illustration of this story. St. George was martyred in Nicomedia in 303.

GEORGE I (1660-1727), King of Great Britain and Ireland, was born at Hanover, Germany, Mar. 28, 1660, the son of the Elector Ernest Augustus, and Sophia, granddaughter of James I of England. He entered the army at 15, and was married in 1682 to his cousin, Sophia Dorothea, daughter of the Duke of Celle. George succeeded to the Hanoverian electorate in 1698, and immediately joined the alliance against France. When his mother was declared a potential heir to the British throne in 1701, George prudently began negotiations for Whig support. On Queen Anne's death in 1714 he became king of England, his mother having died previously. He was thus the founder of the English House of Hanover. His difficulties at the outset of his reign were complicated by his ignorance of the English language and temperament. Indifferent and self-indulgent, he absented himself continually from his kingdom, and left the conduct of affairs largely to his Whig ministers, Stanhope, Townshend, and the astute and ambitious Walpole. The latter's power increased with the king's

growing indifference to British governmental affairs. During his ineffective reign, England fought a brief war against Spain over Gibraltar, 1725, and launched an unsuccessful expedition against the Spanish colonies in America. The king was held partly responsible for the bursting of the South Sea bubble in 1720. More and more he aroused public disfavor by his frequent journeys to Hanover. It was on one of these that he died; at Osnabruck, Germany, June 11, 1727.

GEORGE II (George Augustus) (1683-1760), King of Great Britain and Ireland, was born in Hanover, Germany, on Nov. 10, 1683, son of George I. In 1705 he was married to Wilhelmina Caroline of Anspach. Three years later he fought with Marlborough at OUDENARDE and Dettingen. He was created Prince of Wales in 1714 upon the accession of George I to the throne. During his father's visit to Hanover in 1716 he served as regent. He mounted the throne in 1727, and began his reckless reign of 33 years by displaying his father's preoccupation with Hanover. He retained Walpole as prime minister until 1742, because he recognized Walpole as his superior in sagacity. Motivated by his Hanoverian interests, he engaged in the WAR OF THE AUSTRIAN SUCCESSION and the Silesian wars of 1740-42 and 1744-45. At the conclusion of the SEVEN YEARS' WAR, 1756-63, England under the leadership of William Pitt the Elder retained her conquests in America and India, and held a commanding position in Europe. Although he was a mediocre ruler, George II fortunately allowed his wisest ministers a free hand. He sponsored the musician Handel, and founded the University of Göttingen. He died at London on Oct. 25, 1760.

GEORGE III (1738-1820), King of Great Britain and Ireland, was born in London, June 4, 1738, the son of Frederick Louis, Prince of Wales (d. 1751), and the grandson of George II. The royal heir mounted the throne in 1760 as the first of the Hanoverian house to be born and reared in England. The next year he married Princess Charlotte Sophia of Mecklenburg-Strelitz. The young king's first act was to bring about the resignation of the elder Pitt in 1761, and thenceforth he worked unceasingly to get government control in his own hands. He dismissed his chief Whig cabinet officers. George Grenville became minister in 1764, and succeeded in passing the momentous Stamp Act before the king ousted him from office. George's succession of ministers in the next 12 years gave the monarch control of the government, a factor in the prevailing civil dissatisfaction. Meanwhile, the sentiment against George in the American colonies was rapidly spreading, and the king's arbitrary assumption of right to tax the colonists led to open revolt in 1773. Throughout the ensuing hostilities, the king ruled the country and prosecuted the colonial war through his minister Lord North. Having lost an empire in the AMERICAN REVOLUTIONARY WAR, George felt momentarily impelled to abdicate, but he managed to maintain a degree of popularity with his subjects, owing per-

haps to his active interest in all state affairs. He vigorously supported the younger Pitt in the legislative union of Great Britain and Ireland in 1801, but his determined opposition to Catholic Emancipation caused the resignation of his prime minister. Parliament found the king unflagging in his opposition to the French Revolution and Napoleon, in the warfare which continued from 1793 to 1815, with only a brief year of peace after the Treaty of Amiens. The king's compulsory retirement in 1811 followed repeated and increasingly evident symptoms of insanity, which had first showed themselves in 1765. Upon his complete collapse, his second son, later George IV, acted as regent until the king's death in London, Jan. 29, 1820.

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GEORGE IV (1762-1830), King of Great Britain and Ireland and eldest son of George III, was born in London on Aug. 12, 1762. He received an excellent classical and general education, and promised, by reason of his talents and handsome face, to be "either the greatest gentleman or the greatest rogue" in Europe. As Prince of Wales he formed certain habits, including reckless expenditure and dissipation, that were unbroken until his death. In 1785 he illegally married a beautiful and reputable Catholic lady, Mrs. Fitzherbert. Ten years later, in order that Parliament would consent to pay his debts, he married Princess Caroline of Brunswick. Within a year after the birth of their only child, Charlotte, the prince separated from Caroline. From 1811 until his accession the Prince acted as regent during the insanity of his father. After his coronation in 1821, from which Caroline was excluded, George IV became one of the most disliked kings in English history because of his vices and his opposition to political progress. However, three great legislative reform acts were passed during his reign: the repeal of the Corporation Act; the repeal of the Test Act; and the famous Catholic Emancipation Act of 1829, passed by the Wellington ministry which George had had formed in 1828. George IV died in London on June 26, 1830, and was succeeded by his brother as William IV. *See ENGLAND: Constitutional Development.*

GEORGE V (1865-), King of Great Britain, Ireland and of the British Dominions beyond the Seas, Defender of the Faith, Emperor of India, was born at Marlborough House, London, on June 3, 1865. He was the son of Albert Edward, Prince of Wales, afterwards King Edward VII, and Alexandra, his full name being George Frederick Ernest Albert. He was 18 months younger than his only brother, Albert Victor, Duke of Clarence. In early years, the boys were taught by a tutor, John Neale Dalton, curate of Sandringham, his parents' country home in Norfolk. At the age of 12, George accompanied his brother to the training ship, *Britannia*, where the princes served for two years as cadets, and in July, 1879, they proceeded as midshipmen to the *Bacchante*,

a full-rigged corvette, with merely auxiliary steam-power. The princes cruised for two years, seeing the West Indies, Africa, the Far East and the Mediterranean.

In 1882, Prince George was appointed to H. M. S. *Canada* and for 10 years he served as a naval officer, rising by promotion to be commander of H. M. S. *Melampus*. But at this point, his professional career was interrupted. Both the brothers were attacked by grave illness. Prince George recovered from typhoid, but on Jan. 14, 1892, the Duke of Clarence succumbed to influenza, and Prince George became prospective heir to the throne.

On July 6, 1893, Prince George married Princess Mary, daughter of the Duke of Teck, who had been betrothed to the Duke of Clarence. The Prince became Duke of Cornwall and York. On the death of Queen Victoria in 1901, the Duke and Duchess of York undertook a tour of the colonies, inaugurating the Parliament of Australia, and later in the year, the Duke succeeded to the title Prince of Wales. On May 6, 1910, he ascended the throne as George V, and on June 22, 1911, the King, with Queen Mary, was crowned in Westminster Abbey. Two precedents were created: first, the King insisted that words offensive to Roman Catholics should be eliminated from the Oath of Accession in which he declared himself to be "a faithful Protestant"; second, their Majesties undertook the journey to India where, on Dec. 12, 1911, they held a Coronation Durbar.

The King had to face a prolonged constitutional crisis. On the advice of Prime Minister Asquith, the sovereign indicated his readiness to create peers for the purpose of passing the Parliament Act of 1911 which limits the veto of the House of Lords. In 1914, a conference of all parties was held at Buckingham Palace in a vain attempt to settle the Irish question. The outbreak of the Great War immediately followed, and the calamity resulted in the collapse of many thrones. Two of the King's first cousins, Emperor William of Germany and Czar Nicholas, were involved in revolutions. But the sincerity of King George and Queen Mary, their deep devotion to duty, and their courage at a dark time silenced all tendency toward criticism.

The reign of George V has been one of far-reaching events. It saw not only the victory of the Allies in the World War but also the permanency of the British monarchy while the monarchs of powerful nations were toppled from their thrones. It brought further stabilization of the relations between the component parts of the Empire, and substituted for "British Empire" the more felicitous "British Commonwealth of Nations." In dealing with the Irish question England concluded the Anglo-Irish treaty of 1921, which brought the problem closer to a satisfactory settlement than it had ever been. In the domestic affairs of England the Labor party formed its first government in 1924 with RAMSAY MACDONALD as premier, the great national strike occurred in 1926, and there was a Parliamentary controversy in a religious matter in

1928. As a result of the world economic depression, England in 1931 temporarily suspended the gold standard of currency. See EDWARD VII; PRINCE OF WALES; HOUSE OF WINDSOR.

GEORGE, DAVID LLOYD. See LLOYD GEORGE, DAVID.

GEORGE, HENRY (1839-97), American economist and author, was born at Philadelphia, Pa., Sept. 2, 1839. After working as printer and journalist in California, he settled in New York City in 1880, having already become known as the exponent of the theory of economic organization to which he gave the name SINGLE TAX. He held that the earth belonged to all men equally, that only land should be taxed, and that the operation of this doctrine would abolish extremes of wealth and poverty and establish justice in the social order. He published his first essay on the subject in 1871; his famous and immediately popular work, *Progress and Poverty*, appeared in 1879. He traveled in Great Britain in 1881, lectured widely and, although he never sought political preferment, attained great public support. Among his other writings are *The Irish Land Question*, 1881, *Social Problems*, 1884, and *Protection or Free Trade*, 1886. He died at New York City, Oct. 29, 1897.

GEORGE, STEFAN (1868-), German poet, was born at Büdesheim, Hesse, July 12, 1868. He was educated at Berlin, Munich and Paris, and traveled throughout Europe. In 1892 the poet founded *Blätter für die Kunst* and thereafter stood as the chief German advocate of the short-lived Pre-Raphaelite movement. Stefan formed a link between a group of German writers and the French symbolists, some of whose works he translated. Among his own works are *Hymen*, 1890, *Tage und Taten*, 1900, *Stern des Bundes*, 1914, and *Drei Gesänge*, 1921.

GEORGE, WALTER LIONEL (1882-1926), English author, was born in Paris, Mar. 20, 1882, of British parents, and was educated in Paris and Germany. He contributed to many London publications, and served as special correspondent of various papers in France, Belgium and Spain. He enlisted in the French Army and during the World War was section officer in the Ministry of Munitions. His published works include various political and economic works, but he is best known as a novelist. Among his novels are *A Bed of Roses*, *Blind Alley*, *Caliban*, *The Confession of Ursula Trent* and *Gifts of Sheba*. George died Jan. 30, 1926.

GEORGE, LAKE, a lake in eastern New York State and a tributary to Lake Champlain. It is about 30 mi. long, and is narrow; it has a surface area of 50 sq. mi. and an average depth of 400 ft. The level of its waters is at an elevation of 323 ft. The lake drains into Lake Champlain, 228 ft. below it, through a series of cascades, including an abrupt fall of 30 ft. at Ticonderoga. One striking feature of the lake is its great number of miniature islands and the unusual beauty of its environs. The Indians called it Horicon meaning Silver Water. Lake George was the scene of many important events in Colonial and

Revolutionary days. On its shores is Fort Ticonderoga the scene of the exploits of ETHAN ALLEN and his Green Mountain boys.

GEORGE JUNIOR REPUBLIC, a self-governing community of about 150 young people of both sexes, 16 to 21 years of age, at Freeville, New York. It was founded in 1895 after William Reuben George, its originator, had concluded from his experience in summer outings for city children that they were pauperized by such charity. The miniature state reproduces the economic, civic and social conditions of the larger society so far as they are supposed to affect the character of the citizens many of whom have been neglected or wayward children. Payment in labor is required for everything the citizens receive. There is complete self-government, except for the veto power of the superintendent. The religious influence brought to bear is strong but unsectarian. Schooling consists of elementary and high school from which the citizens enter various colleges. In 1908 the National Association of Junior Republics was formed of three such institutions and others have joined since. Woman's Aid societies in several cities promote the work of the Republic.

LE R. E. B.

GEORGETOWN, the capital of BRITISH GUIANA and the chief port of the Guianas, situated at the mouth of the Demerara River. It is a tropical garden city with broad streets, a museum, electric illumination and street car service. On account of dampness the houses are all built on pillars. The climate is considered good though there is large rainfall averaging 93 in. a year. There is little industrial development other than sugar and cacao factories and cigar-making establishments. Pop. 1931, 61,899.

GEORGETOWN, a seaport and the county seat of Georgetown Co., situated on Winyah Bay on the coast of South Carolina, about 65 mi. northeast of Charleston. The Seaboard Air Line Railroad, bus lines and steamship lines serve the city. Cotton and tobacco are the chief crops of the region. Lumber and fish scrap and oil are among the important manufactures. Lafayette and Washington visited here and Thomas Lynch, signer of the Declaration of Independence was born near the city. Georgetown was founded in 1734 and the city was chartered in 1892. Pop. 1920, 4,579; 1930, 5,082.

GEORGETOWN UNIVERSITY, a Catholic institution located at Washington, D.C., was founded as Georgetown College in 1789. In 1805 control of the college was transferred to the Fathers of the Society of Jesus. The power of conferring degrees was granted by Congress in 1815, and the university was formally incorporated by Congress in 1844. To the original college have been added schools of Medicine, Law and Dentistry, a Graduate School, Hospital, Training School for Nurses, Astronomical Observatory, Seismic Station and a School of Foreign Service. Women are admitted only to the Nurses' Training School.

The university has productive funds which amount to about \$3,000,000. Riggs Memorial Library con-

tains 285,572 volumes and includes the John Gilmary Shea Collection of Americana and Indian Languages and the Morgan Collection of Colonial History. The Astronomical Observatory contains much valuable equipment. The Seismic Observatory is in a specially constructed cave beneath the college quadrangle. In 1930-31 there were 2,842 students and a faculty of 379, headed by the president, the Rev. WILLIAM COLEMAN NEVILS.

GEORGE WASHINGTON BRIDGE, at completion the longest suspension bridge in the world, extending across the Hudson River from 178th Street, Manhattan, New York City, to Fort Lee, N.J. It was formally opened Oct. 24, 1931. Financed, constructed and operated by the Port of New York Authority, its total cost was approximately \$60,000,000. The bridge is suspended by four wire cables, each of 36 in. diameter; its towers are 635 ft. above the water and it has a channel span of 3,500 ft. It is constructed for eight lanes of vehicular traffic and four transit lines.

GEORGE WASHINGTON UNIVERSITY, at Washington, D.C., a privately controlled and non-sectarian coeducational institution, chartered as Columbian College in 1821. It became Columbian University in 1873, and George Washington University in 1904. The institution had productive funds in 1931 of \$1,586,565. The library of 92,000 volumes contains the Heinzel Collection in Germanic Philology and Literature, and the American Institute of Architects' Collection. In 1930 there were 8,585 students, and a faculty of 428 headed by Pres. CLOYD H. MARVIN.

GEORGIA, one of three republics forming the Transcaucasian S.F.S.R. It is bounded on the west by the Black Sea, on the east by Daghestan, on the north by the southern stretch of the Caucasian Mountains, and on the south by the sister republics of Armenia and Azerbaidjan. The state embraces a territory of 26,318 sq. mi. The surface is varied, with mountains, like Kazbek, rising to approximately 17,000 ft. above the sea, and with low valleys of considerable fertility. Agriculture is an important industry. The chief crops are wheat, barley and other grains, fruit, especially grapes, and vegetables. The country has extensive pasturage, and stock-raising is a leading occupation. The forests of Georgia are noted, but the lumber industry is not extensively developed due to lack of proper facilities. In mineral resources the republic is one of the wealthiest regions in Transcaucasia, being particularly rich in coal and manganese. The manganese deposits, the largest in the world, are estimated at 150,000,000 tons and those of coal at 1,300,000,000 tons. The scattered inhabitants live in remote and illiterate communities, speaking a variety of dialects.

TIFLIS, pop. 1930, 320,000, is the capital of Georgia and of the Federation of Transcaucasian Republics. Pop. 1930, 2,857,000.

GEORGIA, a southern state, and one of the original thirteen states of the Union, popularly called

the "Cracker State." It is situated between $30^{\circ} 32'$ and 35° N. lat. and 81° and $85^{\circ} 54'$ W. long. On the north it is bounded by Tennessee and North Carolina, on the east by South Carolina and the



GEORGIA STATE SEAL

Atlantic Ocean, on the south by Florida, and on the west by Alabama. Georgia comprises an area of 59,265 sq. mi., inclusive of 540 sq. mi. of water surface. In size Georgia ranks twentieth among the states of the Union.

Surface Features.

Georgia comes within two main topographical regions, the Appalachian Mountain province and the Atlantic and Gulf Coastal Plains. They can be separated by a line drawn from Columbus through Macon to Augusta.

The mountain province which crosses the north-western half of the state, is made up of a section of the Cumberland Mountains at the extreme north-western corner; a part of the Great Appalachian Valley locally known as the Coosa Valley; the southern extremity of the Unaka Mountains, a range of the Blue ridge containing Brasstown Bald, 4,768 ft. high, the loftiest peak in the state and the Piedmont Plateau. The latter is about 65 mi. wide.

The Coastal Plain occupies the remaining half of the state. It is a fertile, sandy lowland with 166 mi. of tidal shore line fringed by numerous semi-tropical islands. In the southeastern corner is Okefenokee Swamp. The entire state has an average elevation above sea level of 600 ft. Its chief rivers are the FLINT, CHATTAHOOCHEE and SUWANEE which flow southward into the Gulf of Mexico and the Altamaha and SAVANNAH which empty into the Atlantic ocean.

Climate. Because of its situation largely within the coastal plain and its small and low mountain area at the north, the climate of Georgia is mild and comparatively uniform. The mean annual temperature for the state is 63.8° F. At Atlanta the average for January is 42.6° F. and for July, 78.1° F. During the period, 1892-1930, the highest temperature recorded in Georgia was 111° F. and the lowest, -12° F. The average annual precipitation is 49.6 in. At Atlanta the growing season averages 221 days.

Forests and Parks. Approximately 36,480,000 acres of a total land area of 37,584,000 acres were originally forested, chiefly with yellow pine, cypress, oak, red gum, yellow poplar and chestnut. The Georgia Forest Service in 1931 estimated the forest and potential forest land at 23,750,000 acres of which about 15,000,000 acres lay within the Pine Belt; 1,000,000 acres were virgin timberland. More than 6,000,000 acres of potential timberland are idle and unproductive. Reforestation has begun on a small scale, 2,542 acres having been planted in 1930 by private individuals. Georgia has two state forests. In 1930 Vogel forest in Union Co., comprised 166

acres of highly scenic country covered with virgin hardwood timber, the nucleus of a proposed forest of about 10,000 acres. Indian Springs, a 10-acre partially forested region, was deeded to the state by Indian treaties of 1801 and 1821. A 158,118-acre section of the Cherokee National Forest extends into northern Georgia, also 96,881 acres of the Nantahala National Forest. Chickamauga and Chattanooga Park, administered by the War Department, is a beautiful region of 6,541.64 acres in Georgia and Tennessee. It embraces the battlefields of Chickamauga and Missionary Ridge and of several other engagements of the Civil War. FORT PULASKI, built in 1810 to replace Fort Greene of the Revolution, and KENESAW MOUNTAIN, the scene of a Civil War battle, are national monuments also administered by the War Department.

Minerals and Mining. So far as developed, the mineral resources of the state although varied are of minor importance. There are valuable deposits of barite, bauxite, asbestos, fuller's earth, and building stone, including limestone, marble, and especially granite, large quantities of which are quarried from Stone Mountain, near Atlanta.

With mineral productions in 1929 amounting to \$15,294,103, Georgia stood thirty-fourth among the states, ranking first in fuller's earth, second in barite, third in bauxite and asbestos, and fifth in granite. Among the important products were stone, 977,910 tons valued at \$6,417,329, including granite, \$2,201,313, marble, \$749,737, and limestone, \$647,113; clay products, \$3,717,673; raw clay, \$2,161,812, and barite, \$626,401. During 1929 86 mines and quarries gave employment to 4,032 persons who received \$3,622,612 in salaries and wages.

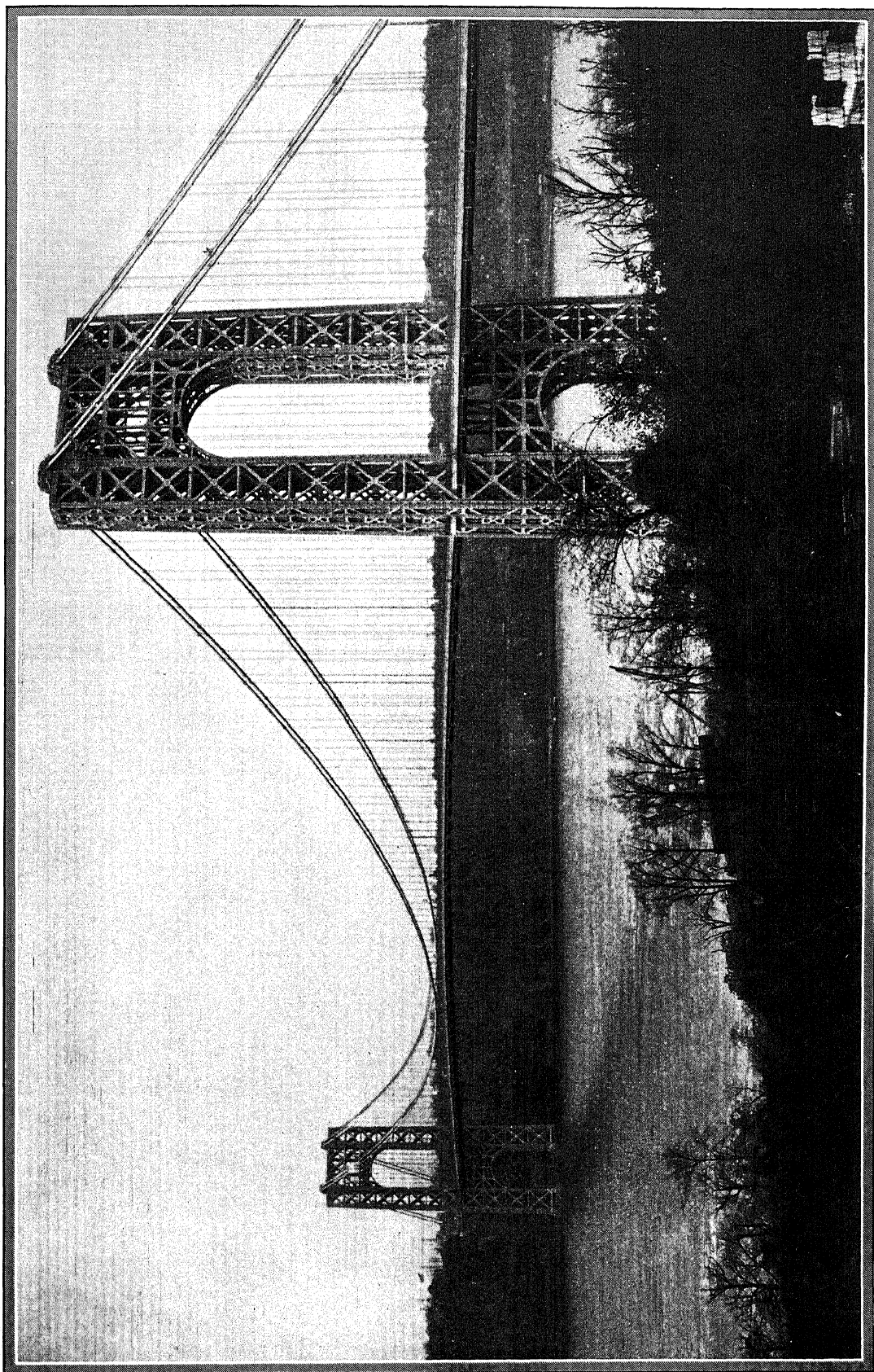
Soil. In the Piedmont section are found the reddish clays and loams characteristic of the southern half of the Piedmont. Along the rivers this region is diversified by rich alluvial bottom lands. Towards the southeast, sandy soils from the sand-hills of the "fall-line" overlie the red clay subsoil. In the extreme southeast are the marshy lands known as the Flatwoods, with an underlying mucky soil. In the western mountain valleys the soil is mostly silt combined with a coarse sand, not well suited to agriculture.

Agriculture. The chief farm products are cotton, grain, vegetables, tobacco and fruits.

In 1930 22,078,630 ac. or 58.7% of the entire land area was in farms, 255,598 in number, with an average size per farm of 86.4 ac. and an average value per acre of \$26.15. Of the farm area 10,446,597 ac. or 47% was crop land; 4,651,627 ac. or 21%, pasture land; and 5,492,579 ac. or 25%, woodland. The total value of farm property was \$683,434,633, of which \$577,338,409 was represented by land and buildings; \$31,216,549, by implements and machinery; and \$74,879,675, by domestic animals.

According to the census of 1930 Georgia produced in 1929 field crops to the value of \$232,422,508, ranking twelfth among the states. It stood fourth in cotton and fifth in cottonseed, sixth in tobacco, first in

GEORGE WASHINGTON BRIDGE



GEORGE WASHINGTON MEMORIAL BRIDGE

This bridge, spanning the Hudson River at New York City, was opened Oct. 24, 1931. Its total length, with approaches, is 8,700 ft. It extends from Broadway and 178th and 179th Streets, Manhattan, New York, to Fort Lee, New Jersey.

GEORGIA

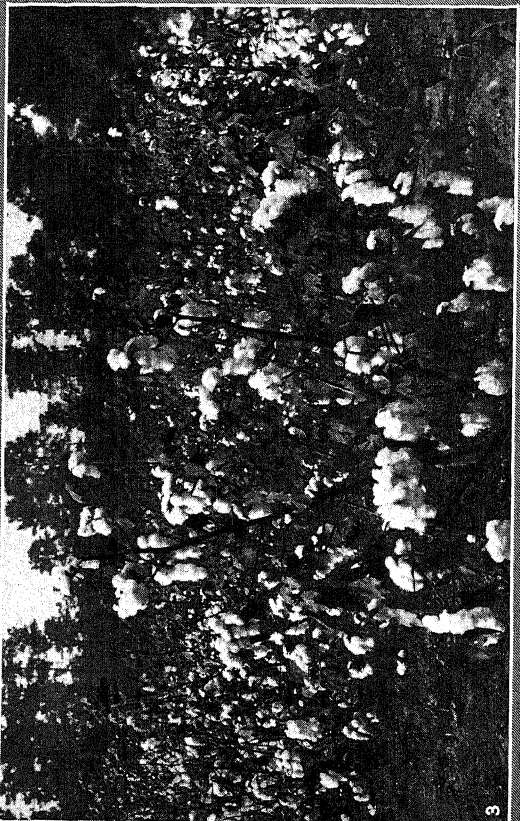
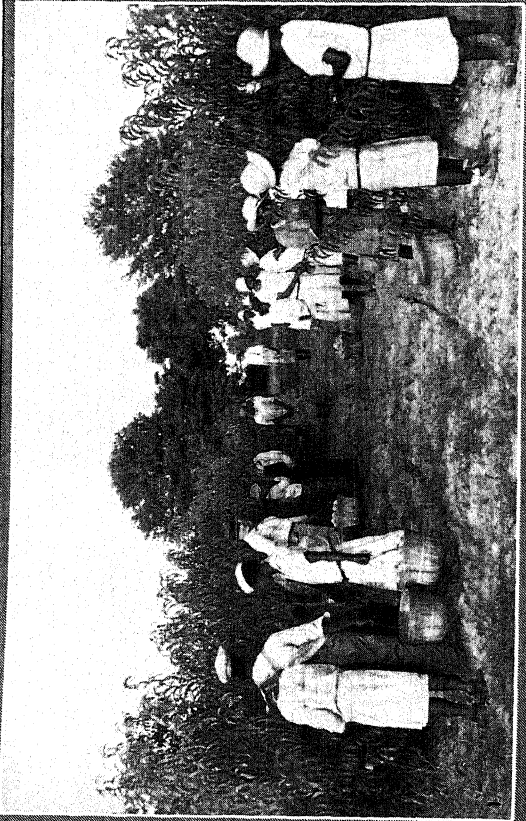
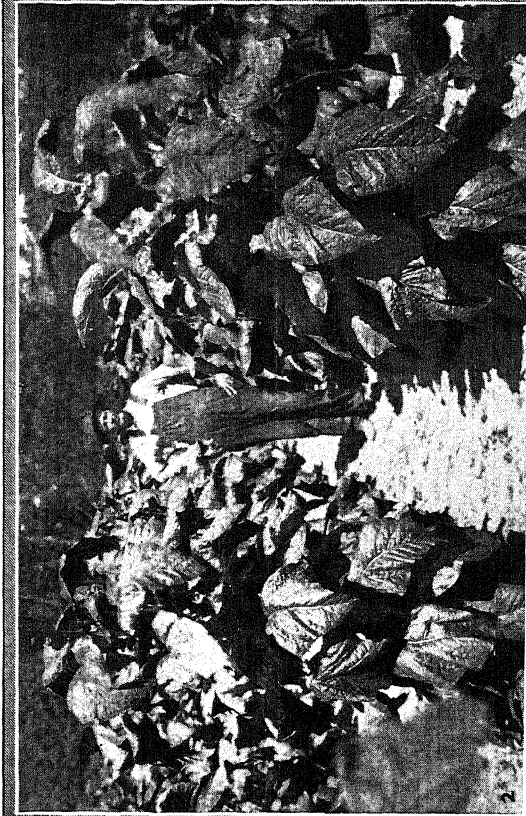


EDGAR ORR PHOTO, COURTESY CHAMBER OF COMMERCE, ATLANTA: 2. COURTESY BOARD OF TRADE, BRUNSWICK

TWO NOTABLE BUILDINGS IN GEORGIA

1. The State Capitol at Atlanta.
2. Christ Church, Frederica. Near this site John Wesley preached to the Indians.

GEORGIA



PHOTOS FROM HART STUDIOS, COURTESY ALBANY CHAMBER OF COMMERCE

GEORGIA'S WEALTH IN DIVERSIFIED FARM PRODUCTS

1. Picking peaches in a healthy young orchard near Albany, Georgia.
2. A luxuriant tobacco crop.
3. Cotton ready to be picked.
4. A paper shell pecan orchard near Albany.

sweet potatoes and watermelons, second in peaches, third in pecans and sixth in figs. The chief crop was cotton, 1,344,488 bales grown on 3,406,443 ac. and valued at \$106,214,552, together with cottonseed, 625,735 tons, \$17,520,580. Other important crops were grains, \$48,485,520, including corn 39,492,897 bu., oats 1,165,731 bu. and wheat 409,472 bu.; vegetables, \$23,252,497; tobacco, 82,363,722 lbs. grown on 90,170 ac. and valued at \$15,402,016; fruits and nuts, \$7,034,545, and hay, 216,682 tons, \$4,601,316. Among the vegetables were sweet potatoes \$6,311,558, watermelons \$2,890,198, and potatoes \$1,231,465. The leading fruit and nut crops were peaches 3,246,263 bu., apples 642,788 bu., pears 151,712 bu., figs 545,606 lbs., strawberries 1,055,152 qts., and pecans 3,809,177 lbs. Georgia produced 4,783,069 gals. of sugar cane for sirup, the largest yield of any state, and 649,401 gals. of sweet sorghum.

Farm products sold by cooperative marketing rose from \$890,605 in 1919 to \$3,659,998 in 1929. Farm machinery and equipment in 1930 included 88,479 automobiles, 15,967 motor trucks, 5,870 tractors, 1,246 electric motors, and 5,000 stationary gas engines.

Animal Industry. Mule-raising, in which Georgia ranks fourth among the states, and cattle-raising are the chief livestock interests. According to the census of 1930, the state ranked twenty-eighth in total value, \$74,879,675, of domestic animals on farms. Among these were mules, 353,633, valued at \$34,402,879; horses, 37,325, \$2,529,202; cattle, 782,063, \$24,837,903; swine, 1,357,400, \$8,424,323; sheep, 49,690, \$206,676, and goats, 88,082, \$148,493.

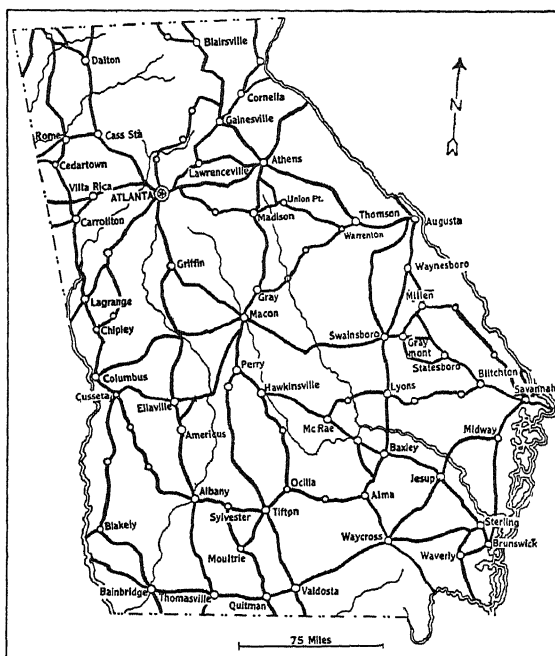
Of the cows on farms 341,681 were kept mainly for milk production and 107,525 mainly for beef production. In 1929, 113,639,532 gals. of milk were produced; the butter churned on farms amounted to 26,690,508 lbs. The total value of dairy products sold was \$10,560,047. The value of all poultry raised, chiefly chickens, was \$9,193,859; the chickens sold were valued at \$2,982,006. Of 30,533,675 doz. chicken eggs produced, valued at \$9,485,212, 14,180,785 doz., with a value of \$4,407,352, were marketed. Honey, amounting to 1,698,431 lbs. valued at \$264,288, was produced from 108,729 hives.

Fisheries. Although the fisheries of Georgia are not of great importance, the catch for 1930 amounted to 43,514,000 lbs., valued at \$877,000. The leading species include oysters, shad, red snapper, terrapin, catfish and sea bass. From the single state hatchery, 600,000 trout were put out, at a cost of \$6,859.24. The United States Bureau of Fisheries planted the following during 1930: 2,575 catfish, 685,950 rainbow trout, 203,575 large mouth black bass, 97,435 sunfish and 16,400 Warmouth bass.

Transportation. Ocean-going steamers afford Georgia good transportation facilities by water. The principal ports are Savannah, Brunswick, Darien and St. Mary's. The Savannah and Chattahoochee rivers, navigable to Augusta and Columbus, and the Oconee, Ocmulgee and Flint rivers afford transportation to light draft boats. However, the railways are the

mainspring of the state's transportation system. The Georgia Central, the Southern, the Seaboard Air Line, the Atlantic Coast Line, the Atlanta, Birmingham and Atlantic and the Georgia systems form an efficient railway network across the state. In 1930 the aggregate railway mileage was 6,762.

The highway system is showing extension and improvement. In 1930 there were 116,253 mi. of highways, including 14,831 mi. of surfaced roads and 3,854 mi. of state highways. The total highway



GEORGIA STATE ROADS

expenditure during 1929 was \$17,135,759, of which \$7,038,986 was paid by the state and \$10,096,773 by county and local governments. The state gasoline tax produced a gross revenue of \$13,435,062 in 1930. Motor vehicle registrations were 341,580 in 1930, compared with 248,093 in 1925, an increase of nearly 38%. The growth of trucking facilities is shown by a truck registration of 47,119 in 1930 as against 30,515 in 1925. During the same period, the number of buses in operation increased from 644 to 1,505, or over 133%.

Manufactures. Although the interests of the state are in the main agricultural, Georgia has substantial manufactures. These have been developed chiefly in connection with the state's extensive agricultural productions and to a lesser degree with its forest and mineral resources. Very important factors have been the utilization of abundant water power and low-priced labor, and also nearness to supplies of raw materials.

According to the Census of 1930 Georgia with manufactures for 1929 valued at \$722,453,803 stood twenty-second among the states, ranking first in fertilizers and turpentine, third in cottonseed oil, fourth

in cotton goods, and ninth in knit goods. Its 4,179 establishments gave employment to 12,960 officers and employees, who received \$30,238,560 in salaries, and to 158,774 wage earners, who were paid \$110,435,015 in wages. These factories used a total of 641,899 horse power, expended \$15,339,441 for fuel and power, and \$412,465,647 for materials and supplies, and added by the process of manufacture \$294,648,715 to the value of their output.

Of about 75 manufactures separately reported by the Census the outstanding product was cotton goods valued at \$212,851,829, or 30% of the factory output of the state, a total surpassed only by North Carolina, South Carolina and Massachusetts. Next in aggregate value were forest and timber products amounting to \$64,324,389, including lumber, \$31,180,191; turpentine and rosin, \$18,076,499, and planing mill products, \$15,067,699. Other important manufactures were fertilizers, \$29,252,800; cottonseed oil, cake and meal, \$24,894,917; printing and publishing, \$21,689,814, and knit goods, \$19,377,923.

Atlanta with its environs is the principal industrial center. Fulton Co., in which the city is situated, produced an output valued at \$215,223,672, or 30% of the state's manufactures. To this total Atlanta contributed an output of \$136,947,488. Next in value of products were Columbus, \$39,664,527; Macon, \$29,612,150; Augusta, \$26,361,617; La Grange, \$21,104,084, and Savannah, \$14,725,236.

Commerce. According to the census of 1930, there were in 1929 3,183 wholesaling establishments in Georgia, with total sales of \$1,016,495,832. These organizations gave full-time employment to 22,735 men and women whose annual salaries aggregated \$36,895,640. Half of the total wholesaling volume for the state was developed in Atlanta, the most important distributing point in the southeast. Savannah and Augusta are also important.

The total sales of the 28,768 retail stores amounted to \$617,543,956. Sales per store averaged \$21,466; sales per capita were \$212.32.

CHIEF RETAIL DISTRIBUTING GROUPS

Group	No. of Stores	Sales	% of Total
General Mdse.	5,060	\$151,004,278	24.46
Food	10,485	134,035,398	21.71
Automotive	4,527	126,536,789	20.49
Apparel	1,088	40,070,578	6.49
Furn. & Household ..	674	29,196,485	4.72
Lumber & Bldg.	695	27,994,714	4.53
All other stores	6,239	108,705,714	17.60
Total, all stores ...	28,768	\$617,543,956	100.00

Savannah, the principal port, handled water-borne traffic amounting to 2,475,110 tons, with a value of \$347,170,298. The largest items of export were cotton, sugar, rosin and lumber.

Finance and Banking. The assessed value of all Georgia property in 1929 was \$1,311,069,248. The total bonded debt on Jan. 1, 1930 was \$4,690,000. Total revenue receipts for the year ended Dec. 31, 1929 were \$28,135,650; total expenditures were \$27,-

732,041. The chief sources of revenue were general property taxes, \$7,776,400; gasoline taxes, \$7,678,994; motor vehicle and corporation and franchise taxes. The principal expenditures were for highways, \$11,954,022; permanent improvements, \$10,220,700; and educational aid, \$5,446,803.

There were 411 banks in Georgia in 1930, of which 77 were national banks, 298 trust companies and state banks, and 36 private banks. Their total capitalization was \$38,960,065. Their surplus and undivided profits were \$36,142,000. Their total resources were \$435,431,000, with loans and discounts \$266,696,000. Demand and time deposits, including postal savings, aggregated \$294,727,000. Per capita demand and time deposits, including postal savings, were \$101.32; per capita savings deposits, \$45.80. The total savings of \$133,222,000 were owned by 390,950 depositors. National bank circulation aggregated \$7,677,000.

Government. The law-making power of Georgia is vested in the general assembly consisting of a senate composed of 51 members and a house of representatives of 206 members, all elected for terms of two years, meeting in annual sessions limited in duration to 50 days. The governor is the chief executive, elected for a term of two years with a salary of \$7,500 per annum. He may serve for two consecutive terms and is then ineligible for re-election for four years. He has the power of pardon and of veto, but a two-thirds vote of each house will override his veto. The highest judiciary power is vested in the supreme court, consisting of six judges elected for terms of six years with salaries of \$7,000 per annum.

Social Welfare Institutions. The state has at Milledgeville a hospital for the insane and also a training school for delinquent boys. The training school for girls is at Atlanta and the home for mental defectives at Gracewood. A home for Confederate soldiers is maintained at Atlanta. The Juvenile Industrial Farm for Negroes is at Savannah. There is an institute for the deaf and dumb at Cave Spring and one for the blind at Macon. The state tuberculosis hospital is at Alto. The state penitentiary is at Milledgeville.

Education. The first schools of Georgia were provided for by the trustees of the colony in laying out the original towns. The most notable of these early schools was established in 1739 by the evangelist, George Whitefield, as described in Franklin's *Autobiography*. A free school law passed in 1868 provides separate schools for whites and Negroes. In 1929, the 6,855 elementary schools had 623,508 pupils and 15,135 teachers, and the 1,721 high schools, 81,428 pupils and 3,914 teachers. All children from 8 to 14 years are required to attend school four months of the year.

In 1930 the number of persons 5 to 20 years of age attending school was 660,964, or 60.4% of the population within the ages specified. In 1920 this number was 619,025, or 55.7%. The number of persons 10 years and over who could not read or

write in 1930 was 210,736, or 9.4%, as compared with 328,828, or 15.3%, in 1920. Negro illiterates numbered 163,237, or 19.9%, in 1930; and 261,115, or 29.1%, in 1920. Native white illiterates dropped from 66,796, or 5.4% in 1920, to 46,898, or 3.3%, in 1930.

The University of Georgia at Athens heads the state university system, and by law all state controlled institutions are branches of the university. These include the Georgia School of Technology at Atlanta, the Georgia State College for Women at Milledgeville, the State Women's College at Valdosta, the State Industrial College for Colored Youths at Savannah, and eight normal schools. Among the private institutions are Agnes Scott College at Decatur, Oglethorpe University, Emory University at Atlanta and Mercer University at Macon. Atlanta University is the most widely known of the five colleges for Negroes. The State Library Commission has headquarters in the State Capitol at Atlanta.

Population. In 1930 Georgia ranked fourteenth among the states with a population of 2,908,506 or an average of 49.5 per square mile, an increase of 12,674 or 0.4% over the population of 1920. The population rose from 82,548 in 1790 to 1,057,286 in 1860, 2,216,331 in 1900, 2,609,121 in 1910, and to 2,895,832 in 1920. In 1930 there were 1,836,974 or 63.2% whites and 1,071,125 or 36.8% Negroes, an increase from 1920 of 8.7% whites and a decrease of 11.2% Negroes. Of the whites, 1,823,057 were native born and 13,917 were foreign born. The rural population was 2,013,014 or 69.2% of the total, a decrease of 154,959 or 7.1% from 1920; the urban population was 895,492 or 30.8% of the total, an increase of 167,633 or 23.0% since 1920. In 1930 the five largest cities were Atlanta, 270,366; Savannah, 85,024; Augusta, 60,342; Macon, 53,829; Columbus, 43,131.

Occupations. In 1930 1,162,158 persons, or 40% of the population, were gainful workers 10 years old or older; 73.2% of these were males and 26.8% were females; 56.8% were native white; 0.7% foreign-born white, and 42.5% Negro.

In agriculture, the principal occupation, 497,941 persons were engaged, including 249,314 farmers and 114,930 farm wage earners. Among other important occupations, with number of workers, were cotton mill workers, 27,208 men and 19,944 women; building laborers, 17,797; lumber mill workers, 16,699; chauffeurs, 14,386; carpenters, 14,199; retail dealers, 27,975; salesmen, 22,733, and saleswomen, 7,970; teachers, 2,893 men and 17,243 women; laundresses, 42,013; cooks, 30,903; clerks, 24,741, and bookkeepers and cashiers, 10,070.

HISTORY

Georgia was traversed by FERNANDO DE SOTO in 1540, and Jean Ribaut in 1562 touched its coast. Spaniards from the FLORIDA settlements traded with the Cherokee and Creek inhabitants of the Georgia country, and worked a few mines. The region was

included in the Carolina charter granted by Charles II of England in 1660; the Carolina colonists did not occupy it, but captured most of the Indian trade. In 1730 the Carolina proprietors sold seven-eighths of the Georgia territory to the Crown, which acquired the remaining eighth from Lord Carteret in February, 1732. The territory was ceded, on June 8, 1732, to a body of trustees, headed by JAMES EDWARD OGLETHORPE, who were to establish "the Colony of Georgia," named after the grantor, George II. The trustees designed to found a refuge for the indigent debtors of England and for oppressed Protestants; the Crown and the Carolina proprietors welcomed a buffer colony to restrain the Spaniards of Florida. Parliament appropriated £10,000 for the enterprise. Oglethorpe, selected as first governor, brought over 116 emigrants of diverse nationalities; after negotiation with the Creek Indians, the party laid the foundations of Savannah on Feb. 13, 1733. Jewish immigrants in 1733, Salzburger or German Lutherans in 1734 and Scottish Highlanders in 1736 contributed to the expansion of the colony. The trustees attempted to direct the economic life of the settlements, encouraging the production of grapes, hemp, silk, and medicinal herbs, forbidding the introduction of rum or of slaves. The experiment failed; slavery was introduced in 1749, and the semi-feudal system of land tenure was revised in 1750. Meanwhile, peace with the Indians had been secured by treaties. A Spanish invasion in 1742 was repelled. In 1751 the first provisional assembly was convened. In 1752 the trustees surrendered their rights to the Crown.

The REVOLUTIONARY WAR found Georgia, little affected by the grievances of the northerly colonies, divided against itself; since Loyalist and Revolutionary parties were almost equal in numbers, severe civil conflicts ensued. A state constitution was adopted in 1777. In 1782 Georgia ceded its western lands, embracing the greater part of Alabama and Mississippi, to the Confederation. Georgia's delegates at the CONSTITUTIONAL CONVENTION supported measures designed to strengthen the national Government; but once the new government was established, differences arose which made Georgia a vehement champion of state sovereignty. No Federal marshal dared execute the decision in *Chisholm vs. Georgia*; in the YAZOO CLAIMS affair and in its general policy of expelling the Indians, the state either ignored obstacles placed by the federal Government or forced a favorable compromise. By 1836, through the influence of Pres. ANDREW JACKSON, who commanded in the CREEK WAR, the Creeks had been removed from Georgia and the Cherokees had promised to leave. Divided politically into an aristocratic, slave-holding faction and a faction of non-slave-holders and frontiersmen, the state was keenly sensitive to each new phase of the slavery controversy, until in 1856 the ultra-slavery party attained supremacy. Lincoln's election was held sufficient grounds for secession. Georgia furnished to the Confederate army 94 regiments and 36 battalions, embracing every branch of service. Its ports were block-

aded in 1862, and in 1863 began the intensive campaign which was to destroy four-fifths of the public wealth of the state (*see* CIVIL WAR). Georgia was restored to the Union by an act of Congress, July 15, 1870. The capital, removed from Savannah to Louisville in 1795 and to Milledgeville in 1807, was fixed at Atlanta in 1868. The RECONSTRUCTION period was not oppressive; by 1872 the Democrats were in control, and the state was part of the SOLID SOUTH thereafter. In 1932 its 12 electoral votes went easily to Roosevelt. Eugene Talmadge was elected governor. Senator Walter F. George was reelected, and the retiring governor, Richard B. Russell, Jr., was elected to the Senate.

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GEORGIA, UNIVERSITY OF, at Athens, Ga., the earliest state university in the United States, was chartered in Feb. 1784, and opened in 1801. Women have been admitted since 1918. By a law which distinguishes the higher education of Georgia from that of every other state in the union, all publicly owned educational institutions in Georgia are a part of the university. The university proper at Athens comprises colleges of Arts, Science and Engineering, and Agriculture; schools of Education, Commerce, Journalism and Law; the Graduate School; and the Pharmacy Department. The library of 63,500 volumes contains collections of Georgiana and early American newspapers. In 1930 there were 1,869 students and a faculty of 120. Dr. Steadman Vincent Sanford was elected president in 1932.

GEORGIAN or **GRUSINIAN**, an important language of the south CAUCASIAN linguistic family, spoken by some 500,000 persons in the Republic of Georgia, and the only member of the entire group whose history is known for any length of time. It is written in two alphabets generally regarded as ultimately derived from Greek: *khutzuri* for religious works, and *mkhedruli* for all other compositions. The consonant-system is richly developed, but grammatical GENDER is lacking. The noun has 11 primary and 12 derivative cases, the case-endings being old prepositions, and the grammatical subject is frequently in the dative, "to the man (is) writing"—"the man writes." The verbs, with six tenses, denote either action or state, the latter often having a passive or inchoative force.

Georgian literature practically begins with King David III (1089-1125) and his famous great-granddaughter Queen Thamar (1184-1212), its themes being both religious and secular and written in prose as well as verse. The period between the 13th and the 17th centuries was one of decline, followed by a revival through Occidental influence, with an ever-increasing tendency to follow Western standards. L. H. G.

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GEORGIAN STYLE, in architecture and the decorative arts, the style that characterized the English

work during the reigns of the four Georges. In architecture it was the development of the monumental and Palladian classic already popular through the work of INIGO JONES, CHRISTOPHER WREN, and their followers. It was distinguished by formality in plan, a widespread decorative use of columns, pilasters and classic moldings of academic correctness, and slight Baroque influence in decorative features such as urns and shields. In small houses the style produced many charming designs in which brick and stone were beautifully combined, with just enough formality to give grace and dignity, and with small amounts of quiet classic detail concentrated at the entrance and around windows. In the interiors of the period there were, in the earlier part, a great use of dignified wood paneling of large panels, and rich classic fireplaces and door frames, with occasional touches of Baroque and rococo detail. The furniture of Chippendale, with its exuberant richness, was characteristic of the earlier part of the period. In it there were many reflections of the contemporary French styles. The taste of the later part, more refined and delicate and classic, is to be seen in the furniture and decorative work of the ADAM Brothers, SHERATON and HEPPLEWHITE.

In general, both in architecture and decoration, the trend of the Georgian period was from the heavier to the more delicate, from the richer and more baroque to the simpler and more restrained. In the last years of the 18th century the Roman taste introduced by the Adam brothers was supreme. The Georgian period in England was closely reflected in much American colonial work. *See* COLONIAL STYLE, and for bibliography, RENAISSANCE ARCHITECTURE; MODERN ARCHITECTURE.

GEORGIA SCHOOL OF TECHNOLOGY, an institution for men founded in Atlanta, Ga., 1888, as the Technical College of Georgia, owned and supported by the State. It is a part of the University of Georgia but has a separate faculty and trustees. Complete electrical, mechanical and civil engineering, physics, chemistry, ceramics, textile and highway laboratories and architectural drafting rooms are maintained. The extension department includes evening schools of applied science and commerce. The library contains 50,000 volumes. In 1931-32 there were 3,200 students enrolled and a faculty of 150 headed by Pres. MARION L. BRITTAIN.

GEORGIA STATE COLLEGE FOR WOMEN, an institution at Milledgeville, Ga., was chartered in 1889 as Georgia Normal and Industrial College. It was the first state controlled educational institution for women in Georgia. The name was changed to Georgia State College for Women in 1922. In 1931 the productive funds were \$235,500. The library contains 23,000 volumes. In 1931-32 there were 1,228 students and a faculty of 86, headed by Pres. Jasper Luther Beeson.

GEOSYNCLINE, a long, narrow belt, usually of the ocean floor, which follows a line of weakness in the earth's crust and progressively sinks as sediments

are piled in it. Such a zone may be 100 or 200 miles broad and many times as long. Eventually crustal movements usually fold and crush the accumulated sediments and push them up into mountain ranges. The Appalachian Mountains were formed in this manner at the close of the PALEOZOIC ERA. Geosynclines can occupy portions of the continent, and the basin of the Lake Superior region is held by some authorities to be such a structure. See also GEOLOGY; SYNCLINE.

GERA, a German city in the province of Thuringia about 34 mi. south and west of Leipzig on the White Elster River. It is the largest city of Thuringia and was the capital of the principality of Reuss Younger Line until 1920. It has considerable industry, aided by the coal fields to the north and south. Particularly important are the woolen mills, iron foundries, machine shops, the factories manufacturing leather goods, tobacco products and musical instruments and trade in grain, leather and lumber. On the market place is a Rathaus of 1576 and a Sampson fountain of 1685. The city has a former ducal castle, built 1686-1735 as a frontier post against the Slavs; the oldest parts date from the 12th century. Pop. 1925, 81,402.

GERANIUM, a numerous genus of plants of the geranium family (*Geraniaceae*). There are about 300 species, mostly perennial herbs, widely distributed

in temperate regions. They are low, usually diffuse plants, with forking stems and round or kidney-shaped, deeply lobed or divided leaves. The flowers vary in color from red, crimson and pink to purple, blue and white. The ripening seed-vessels elongate into a narrow beak, whence the common name cranesbill. About 25 species, native and naturalized, occur in the United States. The wild cranesbill (*G. macu-*



GARDEN GERANIUM

latum), with attractive rosepurple blossoms, is one of the most common woodland wildflowers found in eastern North America. Several species are cultivated, especially the blood-red geranium (*G. sanguineum*), a very useful border perennial.

The hardy pot and garden plants popularly called geraniums are florists' forms developed from various species of PELARGONIUM. Their single or double flowers, borne in heads, range in color from white through varying shades of pink to deep red. As the individual flowers open successively each head may be attractive for as long as three weeks. With the heads appearing in close sequence the plants continue showy for months at a time, until killed by frost out of doors, and all the year round indoors. The principal species reached England from South Africa in 1690; the two species which gave rise to the zonale or beading varieties arrived in 1710 and 1714. These

and some later additions have produced thousands of varieties. Other classes include the ivy-leaved varieties, weak-stemmed and used largely for window boxes and hanging baskets; "show," pelargonium or Lady Washington geraniums brilliantly colored, which are larger but have fewer flowers; and various fragrant-leaved kinds, such as rose, apple, nutmeg and lemon.

GÉRARD, FRANÇOIS PASCAL, BARON (1770-1837), French painter, was born at Rome, May 4, 1770. He was educated at the Pension du Roi, Paris, and studied art with Jacques David whose assistant he became. He made his reputation with *Belisaire*, 1776, and *Psyche et l'Amour*, 1777. He painted portraits of Napoleon I, the Empress Josephine, Talleyrand, Madame de Staël, Madame Recamier and many others. Gérard died in Paris, Jan. 11, 1837.

GERARD, JAMES WATSON (1867-), American diplomat, was born in Geneseo, N.Y., Aug. 25, 1867. He graduated from Columbia University in 1892 and then began practice in New York City. In 1908 he became a Justice of the New York Supreme Court. President Wilson in 1913 appointed him Ambassador to Germany. With the outbreak of war in 1914 he was forced to handle the constantly strained relations between Germany and the United States. In 1917 with the severance of diplomatic relations, he returned to the United States where he recorded his experiences in *My Four Years in Germany*. He resumed the practice of law in New York City, retaining an active position in Democratic politics.

GERBIL (*Gerbillus*), the name of a group of elegant little rodents inhabiting Africa, Asia and southern Russia. About 40 different kinds are known, all characterized by large eyes, tufted tails, and elongated hind limbs. They are of the size of an ordinary rat, the color of a fawn, and exceedingly prolific. They move in long leaps with extreme rapidity. Their dwellings are widespread connected burrows underground, with numerous exits and large, grass-lined chambers. The best-known gerbils are the Egyptian and the East Indian; the latter does serious damage to grain crops. Most gerbils are nocturnal, and they all emit an offensive odor.

GERD or **GERDA**, in Scandinavian mythology, daughter of the frost giant Cymir and wife of FREY.

GERHARDT, PAUL (1607-76), German hymnologist, was born at Gräfenhainichen, Saxony, probably on Mar. 12, 1607. After studying at Wittenberg and tutoring at Berlin until 1651, Gerhardt accepted a pastorate at Mittelwalde, but in 1657 went to St. Nikolai Church in Berlin. Two years later, on account of his strict Lutheranism and his refusal to obey the edict of the Elector of Brandenburg, forbidding pulpit controversies, he resigned, and was made archdeacon of Lübben, Saxe-Mersburg. His first church hymns were published in 1648, and a complete edition appeared in 1667. The greatest German hymn writer of the 17th century, he shares with Luther the honor of writing the greatest number of hymns for

his church, a large number of which have appeared in the hymnals of other churches. Gerhardt died at Lübben, June 7, 1676.

GERMAN, SIR EDWARD (1862-), English music composer, was born at Whitchurch, Feb. 17, 1862. He studied in London at the Royal Academy of Music. He won a striking success with his incidental music for *Henry VIII*, composed for Henry Irving's production. On Arthur Sullivan's death, German finished the former's opera, *The Emerald Isle*. His *Coronation March* was performed in 1911 at the coronation of George V. In 1922 his centenary song for the Royal Academy of Music was given in London. He was knighted in 1928.

GERMAN, HIGH, an important member of the GERMANIC linguistic family of INDO-EUROPEAN. The term designates 1. geographically, the upper and middle German dialects of the Franconians, Alamannians, Bavarians, Hessians and Thuringians inhabiting the central and southern portions of the empire of Charlemagne; and 2. popularly the literary language evolved from them in modern times as contrasted with the native dialects. Next to English, High German is the most widely used West Germanic language. Its distinguishing characteristic as compared with Low GERMAN is the second, or High German, sound-shift, a continuation of the Germanic, or first, sound-shift (see GRIMM'S LAW). It falls into three periods: Old (750-1100), Middle (1100-1350) and New or Modern (from 1350), the latter being characterized by the development of a common literary language which superimposed itself on the widely varying dialects. This literary language emanated from the chancellery of the emperors of the Luxemburg dynasty in Prague in the 14th century and received a powerful impetus through Luther's use of it in his translation of the Bible in the 16th century (see LUTHER, MARTIN) though complete unification did not take place until late in the 18th century. As the conversational form of High German (*Umgangssprache*) it is making great inroads on the dialects, but it is not, it should be noted, pure High German, being mainly a Middle German of Franconian type, in which there is a mingling of the first and second sound-shifts, e.g., English *God* corresponds in literary German to the Middle form, *Gott*, the true High German *Kott* appearing, for instance, in Bavarian. E. Ro.

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GERMAN, LOW, a comprehensive term for the GERMANIC dialects of the lowlands from the Netherlands to the northeastern boundaries of Germany. Old Low German may be divided into Old Low Franconian, which toward the end of the Middle Ages, developed into DUTCH, spoken in Holland, with the closely related Flemish, spoken in large parts of Belgium; and OLD SAXON. No commonly accepted literary language developed on Low German soil, al-

though during the later Middle Ages the speech of Lubeck gained some prominence over rival dialects, and during the second half of the 19th century the efforts of a number of writers to create a Low German literary language brought about renewed general interest in this form of speech. Since Low German did not take part in the High German sound shift (see GRIMM'S LAW), its consonantal system is most closely akin to that of FRISIAN and ENGLISH.

E. Ro.

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GERMAN ALLIANCE INSURANCE CASE, 1914, a suit which led to a notable decision of the United States Supreme Court affecting the control of public corporations by the states. As an aftermath of the GRANGER CASES, legalists generally held that any business in which a condition of virtual monopoly, due to such limitations as limited sources of supply, restricted access, the necessity of a central location and absence of effectual substitutes, might be subjected by the state legislature to regulation of its charges. The German Alliance Insurance Co. brought a bill in equity to restrain the enforcement of a Kansas statute regulating rates of premium on fire insurance. Justice Joseph McKenna, rendering decision from which three justices dissented, stated that the personal character of the fire insurance business did not in itself preclude regulation; "to the contention that the business is private we have opposed the conception of the public interest." The effect was to broaden the power of state regulation, basing it simply upon the "public interest" as determined by the legislature.

GERMAN BAPTIST BRETHREN, variously called *Dunkers*, *Dunkards*, *Tunkers* and *Dompelaars*, originated in Germany during the 17th century under the leadership of Alexander Mack, who became convinced that the doctrines and principles of church organization set forth in the New Testament were not being followed by either the Lutheran or Reformed churches. The first congregations were established in the Palatinate, and it was from Crefeld that the first Baptist Brethren emigrated to America in 1719 under the leadership of Peter Becker, who settled with his parish in Germantown, Pa. In 1729 a second party arrived under the guidance of Alexander Mack, settling in Philadelphia. The fate of those left in Europe is not known. In the United States they exist in five distinct groups: the Church of the Brethren or Conservative Dunkers, Old Order German Baptist Brethren, the Brethren Church or Progressive Dunkers, German Seventh Day Baptists, and the Church of God or New Dunkers. Their approximately 2,000 churches and 150,000 members are found chiefly in Pennsylvania, Indiana, Virginia, Ohio and Illinois. The distinguishing characteristics of the Dunkers are baptism by trine immersion, the rite of foot-washing, the agape, or love-feast, the veiling of women during prayer, plain attire with virtual abstinence of jewelry, non-resistance in war

and the use of affirmations instead of oaths. The policy of the Church is in part Episcopal and in part Presbyterian.

GERMAN DRAMA. To trace the development of German drama from the Middle Ages to the present would be to trace the history of a large number of more or less interrelated states and principalities, several of them now in the Reich, and others under other political sovereignties; of a variety of political and religious movements, of influences and counter-influences such as few other parts of Europe have known.

The origin of drama in the Germanic lands is to be sought, as elsewhere in Europe, on the one hand in the church, and on the other in folk customs and such semi-dramatic activities as the recitation of ballads and epics, puppet shows, the performances of strolling players, and the like. Except for the single figure of HANS SACHS, who flourished during the first half of the 16th century and marks clearly the division between the spirit of medieval times and the Renaissance and Reformation, and for the somewhat unusual persistence of the Passion Play in Austria and south Germany, German drama can hardly be said to have existed until the advent of GOTTHOLD EPHRAIM LESSING (1729-81) in the middle of the 18th century, although there were writers of comedy and tragedy whose work occasionally rose above mediocrity. Critic, philosopher and playwright, Lessing virtually founded the modern theater and drama in Germany. His *Hamburgische Dramaturgie*, 1767-69, a collection of criticisms which furnished a point of view to his contemporaries and established standards of excellence for playwrights and public, followed close on the production of his *Minna von Barnhelm*, 1767, rightly considered the first native comedy. But 12 years before that he wrote *Miss Sara Sampson*, 1755, the first significant prose tragedy. *Emilia Galotti*, 1772, and *Nathan der Weise*, 1779—this last a great poetic and philosophical drama—were later products.

Lessing provided not only the models for other writers, but was also largely influential in combatting certain foreign ideas and fashions which he deemed harmful, and at the same time pleaded for an acceptance of the ideas of ARISTOTLE and the spirit of SHAKESPEARE and certain other English writers. Shakespeare began to attract translators and critics, and by the early 19th century had a secure position in the repertory of all important native theaters.

Following Lessing were a host of younger men, upon whom the influence of that leader wrought drastic effects on practically all forms of German art, and went far toward establishing self-conscious aims toward national unity among the men of his time.

The year after the production of Lessing's *Emilia Galotti*, 1772, the *Goetz von Berlichingen*, 1773, of J. W. VON GOETHE (1749-1832) was accepted by an enthusiastic group of young people as exemplifying the ideas of the so-called STORM AND STRESS movement in German literature. But *The Robbers*, 1781,

by SCHILLER (1759-1805), was probably the most brilliant example of this type. While other playwrights, chiefly A. W. Iffland (1759-1814), and A. von Kotzebue (1761-1819) contributed moralistic middle-class dramas that were popular and widely influential, Schiller and Goethe experimented with varying success with neo-classic, romantic and sentimental plays.

The early 19th century was a period of intense activity. The Napoleonic wars, the contributions to contemporary thought of such philosophers as Kant, and the stirrings of the national spirit, all contributed to the development of German drama. After the death of Schiller in 1805 other movements came and went, among them the Romantic movement in which Ludwig Tieck, though he wrote no play of the first order, was immensely influential. (See ROMANTICISM.) The two outstanding Romantic playwrights were Zacharias Werner (1768-1823) and HEINRICH VON KLEIST (1777-1811), the latter one of the greatest German dramatic poets. Kleist excelled both in comedy—with *Das Käthchen von Heilbronn*—and in tragedy—with *Prinz Friedrich von Homburg*.

While Germany was developing a national drama, Austria produced her most distinguished playwright, FRANZ GRILLPARZER (1791-1872). Austria, somewhat more susceptible to Italian influences than Germany, had developed not only the so-called *Rokoko* drama that flourished in the operetta and opera during the 18th and 19th centuries, but a species of folk play that has continued to this day. Though Grillparzer represented the more "literary" tradition of Germany and therefore belongs to the German drama proper, the Austrian Ludwig Anzengruber (1838-89) maintained the traditions of his native land and art. The recent Austrian drama, whose outstanding exponents are Hermann Bahr, HUGO VON HOFMANNSTHAL and ARTHUR SCHNITZLER, is a part rather of the Continental post-Ibsen current rather than a purely native product, though folk-plays are still an important part of the dramatic life of the country.

The greatest figure of the 19th century in German drama is Friedrich Hebbel (1813-63), though mention must be made of Karl Immermann (1796-1840), Christian Grabbe (1801-36) and Georg Büchner (1813-37), in whom, though they chose their subject-matter mostly from historical sources, may be detected certain tendencies which were to develop among the so-called Naturalists toward the end of the century; and of the *Jung Deutschland* writers, Karl Gutzkow (1811-78) and Heinrich Laube (1806-84).

In many respects Hebbel definitely announced the dawn of a new era. His *Judith*, 1840, belongs in one sense to the past, but it is not difficult to see in it a forerunner of the kind of play that HENRIK IBSEN was soon to write. *Maria Magdalena*, 1844, was even more distinctly modern in spirit, and while the best of his later plays are symbolic verse dramas on historical and legendary themes, they are none the less products of a genius who was essentially forward-looking.

Except for Otto Ludwig (1813-65), author of *Der Erbförster*, no outstanding figure appeared in German drama until the foundation of the *Free Stage* (*Freie Bühne*), under the direction of Otto Brahm, who gave GERHART HAUPTMANN (1862-), a chance to produce his first play, *Vor Sonnenaufgang*. During the early period of the development of the modern German empire following the conclusion of the Franco-Prussian War in 1871 there was remarkable dramatic activity, but no playwright arose who can be rightly characterized as important. Several writers, borrowing ideas and themes from abroad, excelled in farce and light comedy. The Naturalists—under the influence chiefly of Ibsen, Tolstóy, and Strindberg—ushered in a dramatic movement which has almost up to the present time dominated the contemporary German theater. Aside from Hauptmann, the most important figure in modern German drama is FRANK WEDEKIND (1864-1918), to whom the youngest generation (GEORG KAISER, Walter Hasenclever, etc.) owes most of its ideas and technique, though HERMANN SUDERMANN (1857-1928), a prolific writer, was for a time one of the most widely acclaimed playwrights in the world. His *Heimat*, 1893, known in English as *Magda*, remains an effective play and a particularly interesting document on middle-class German society.

The latest development in German drama has been carried on by several younger men who, influenced by Nietzsche, Wedekind and Strindberg, began writing during or shortly after the World War. Their plays for the most part have proclaimed a spirit of reaction, both philosophical and technical, against the ideas that were current during the Empire. The most interesting trend in their work was what is loosely termed Expressionism, a technical device that, theoretically, enabled them to express the essential spirit of a character or theme without actually describing or representing it; by means of this, such writers as ERNST TOLLER, Arnolt Bronnen, Georg Kaiser and Walter Hasenclever, have expressed varying aspects of the social, moral and political upheaval of post-war Germany. *See also* GERMAN LITERATURE.

B. H. C.

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GERMANIC or **TEUTONIC**, an INDO-EUROPEAN linguistic stock of the *centum*-group (*see* CENTUM LANGUAGES), subdivided into East Germanic (GOTHIC and some other extinct languages), North Germanic or Scandinavian (Swedish, Dano-Norwegian, Icelandic) and West Germanic (English, Frisian, Dutch and German; *see* separate articles on these subjects), English and Frisian being sometimes treated as a separate group, called Anglo-Frisian or Ingvaeonic. The characteristic differences between Germanic and Indo-European are the first, or Germanic, consonant-shift (*see* GRIMM'S LAW), the fixation of a stress-accent on the stem-syllable, incisive reductions in

inflectional forms, two separate forms of adjective-inflection according to whether a noun is or is not preceded by an article, and a new "weak" conjugation of the verb, e.g., English *love-d*, *end-ed*. E. Ro.

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GERMANIUM, a metallic chemical element, symbol Ge, atomic weight 72.6. It is exceedingly scarce in nature, and usually found together with silver or zinc, was discovered in 1886 by Winkler, both its existence and properties, which are intermediate between those of silicon and tin, had been predicated by Mendeleef when he proposed his periodic system of the elements.

GERMAN IVY (*Senecio mikanioides*), a slender, twining species of groundsel much cultivated as a conservatory and window-garden ornamental. It is native to South Africa and sparingly naturalized near the coast in California. The stems grow 5 to 20 ft. high, bearing long-stalked ivy-like leaves and small yellow flower-heads produced in close clusters.

GERMAN LAW. In the fifteenth and sixteenth centuries, Roman law taught in the universities gradually superseded the old Germanic law, and became the basis of the legal system of modern Germany. Prussia adopted a code based on the modern Roman law at the end of the eighteenth century, and there were codes in some of the other German states. But for the most part the modern Roman law prevailed in Germany down to 1900, when a civil code projected in 1873 and completed in 1896, took effect.

GERMAN LITERATURE. August Wilhelm Schlegel (1767-1845) conveniently characterized the chief periods of German literary history as first monastic, then chivalric, next *bourgeois*, and finally learned. The oldest considerable documents extant are of the 9th century and are the work of clerics. Chivalric poetry flourishes in the 12th and early 13th centuries; the *bourgeois* century is the 16th; recovery from the THIRTY YEARS' WAR (1618-48) is sought in the light of learning; and that light has not since failed, however it may have been disdained by individual authors. From another point of view Wilhelm Scherer (1841-86) postulated the years 600, 1200 and 1800 as marking the crests of waves in this same history. Unquestionably chivalry attained its climax at about 1200, and in 1800 not only were the German classical writers at the maximum of their powers, but the enterprising Romantic youths had already issued their manifestoes. The state of things in 600 is more a matter of inference.

Middle Ages. The first information about the Germans comes from the Romans. Tacitus (*Germania*, 98 A.D.) reports that the Germans extolled their gods and heroes in songs and animated their courage when going into battle by chanting the exploits of Hercules, i.e., Thor, as the first of the mighty. Of these unwritten hymns and lays little has been

preserved in any semblance of the original form, but much has entered into medieval compositions, Scandinavian and German, and we are told that a collection of heroic ballads was made by CHARLEMAGNE (768-814). The great migrations were naturally rich in *motifs*. One may recognize a "heroic" period as a prelude to Schlegel's series; a good half dozen of the wandering tribes transmitted to more literary generations stories that reappeared as cycles about their valiant leaders, such as Theodoric the Great (c. 454-526). Theodoric's armorer Hildebrand is the hero of a ballad, or perhaps an episode in an epic poem, of which a fragment has come down in alliterative verse of the late 8th century, the *Hildebrandslied*. The situation is parallel to that in the Persian tale of Sohrab and Rustum. A hundred years later the *Ludwigslied*, monkish in spirit, but in ballad form, celebrates the victory of Louis III over the Normans in 881. This treatment of a contemporary event tends to confirm the theory that there was a "heroic" period shortly after Theodoric's time. But most of the monastic work of the 9th century was devoted to religious subjects. Glosses to the Latin scriptures and translations of Latin treatises have only historical or linguistic importance. Two poems of the time, however, are not without literary interest. The *Heliand*, or "Saviour," c. 830, in Old Saxon alliterative verse, is a doughty effort of Christian propaganda to transform the Prince of Peace into a military chieftain and his disciples into retainers. The *Evangelienbuch* ("Gospel Book") or *Christ* (c. 870) of Otfrid of Weissenburg is in High German rhymed verse, a theological tractate aiming to replace profane songs, and interpreting passages from the New Testament *moraliter*, *spiritualiter* and *mystice*.

Under the Ottos of the 10th century Germany experienced a Latin renaissance. At St. Gall in Switzerland the monk Ekkehard put into Virgilian hexameters a story of the 5th century connected with Attila and the Burgundian kingdom on the Rhine: his *Waltharius manu fortis*, or "Walter of the Strong Hand," c. 930, has a counterpart in the Anglo-Saxon *Waldere*; and at Gandersheim on Saxon territory the nun Hrotswitha treated saints' lives in Latin dramatic form and wrote Latin verses in praise of her monastery. Moreover, at the same monastery with Ekkehard one of the most learned monks of his time, Notker Labeo (c. 952-1022) taught, commented, translated, and achieved what might be regarded as the canon of Old High German prose. To the same century belongs the *Ecbasis Captivi*, "Escape of a Captive," c. 940, an allegorical poem in which beasts symbolize human beings. About a hundred years later falls the Latin *Ruodlieb*, a forerunner of the romances of chivalry.

In the 11th and 12th centuries the clerics, again writing German, devoted themselves chiefly to theological and legendary subjects, and were gradually supplanted by the *Spilleute*, or "gleemen," professional entertainers, in competition for the favor of a new class of society, the knights. These derived,

along with ideals of chivalry, many social conventions and literary interests from France. To the gratification of such interests a clergyman now and then contributed, as when Lamprecht translated (c. 1130) the French romance of Alexander, or Konrad made (c. 1135) a version of the *Chanson de Roland*, but the favorite entertainers were the gleemen, who produced historical ballads, anecdotes (*fabliaux*), and epic poems (*König Rother* c. 1160, *Herzog Ernst* c. 1180) full of marvelous adventures for which the Crusades had gathered material from the mysterious East. These matters, like most of medieval literature, were international. It is probable, however, that gleemen had a hand in the composition of two extensive Middle High German epics of national content, the *Nibelungenlied* and *Gudrun*.

The *Nibelungenlied*, c. 1200, is a combination of Frankish, Burgundian, Hunnish and Gothic sagas with a myth familiar in the tale of the Sleeping Beauty. Its basis is quasi-historical. Elements originally unconnected are organized about the central figure of the Burgundian princess, Kriemhild. A veneer of chivalry and Christianity cannot disguise the pagan ethics of the 5th century. A succession of calamities culminating in the destruction of an entire community condemns, at the same time that it commends, unswerving devotion to the obsolete duty of vengeance for the slain. *Gudrun*, c. 1220, though written in Austria, has its scenes of action on the shores of the North and Irish seas. In this poem too there is a great deal of fighting, but the tone is milder; we peruse a love story through two or even three generations.

Combining folklore with semi-historical matter, the gleemen of the 13th century brought forth an ample body of romantic narrative, mostly related to Theodoric, and assembled under various titles in the so-called *Heldenbuch*, or "Book of Heroes," c. 1280. From the point of view of literary value these epics cannot vie with courtly productions having an international substance, mostly derived from France, and seeking by conscious artistry to exemplify the high ideals of chivalry: loyalty, courtesy, Christianity, service to a lady. Thus Eilhart von Oberge versifies a *Tristrant*, c. 1180; Heinrich von Veldeke turns the *Roman d'Enéas* into an *Eneit*, c. 1175-86; Hartmann von Aue, an especial disciple of Chrétien de Troyes, reproduces his master in *Erec* and *Iwein*, and retells from other sources the legends *Gregorius* and *Der arme Heinrich* ("poor Henry")—the latter supplying Longfellow with the substance of his *Golden Legend* and inviting Gerhart Hauptmann's treatment in more strictly dramatic form; Wolfram von Eschenbach grapples in *Parzival*, c. 1205-10, with the problem of developing an unpromising hero into the *beau idéal* of Christian chivalry; and Gottfried von Strassburg indites the most finished, if perhaps also the most conventional, love story in *Tristan*, c. 1210-15.

From France, especially Provence, come likewise the impulses that give form to lyric poetry assiduously cultivated by German knights and their associates—that *Minnesang*, plaintive, contemplative, of narrow

range but exquisite workmanship, the exacting requirements of which, in respect to both text and music, did not prevent numerous real poets from uttering powerful emotion. (See *PROVENÇAL LITERATURE*.) The most famous then and since was Walther von der Vogelweide (c. 1168-c. 1228). His little book reveals a fervent patriotism, courageous opposition to worldliness in the Church, and a great-hearted humanitarianism far in advance of his time.

The glamor of chivalry did not long survive Walther von der Vogelweide. Political turmoil was itself unpropitious for courtly literature. The poetry of entertainment broadens down to lower levels; didactic verse multiplies; in the 13th and 14th centuries legal prose, religious prose—sermons (Berthold von Regensburg, c. 1220-72), mystical speculations (Meister Eckhart, Heinrich Seuse, Johannes Tauler)—and the religious drama, all point in the direction of the common people, whose commerce and industry furthered the growth of cities and created a public for the *bourgeois* epoch beginning about 1500. One of the choicest illustrations of awakened popular consciousness is the Low German *Reinke de Vos*, or "Reynard the Fox," 1498, translated into hexameters by Goethe under the title *Reineke Fuchs*, a mock-heroic epic descending from an Æsopic fable, and the earliest comprehensive social satire from the point of view of the common man.

The Renaissance. The invention of printing, scientific and geographical discovery, material prosperity, and fuller acquaintance with ancient, more particularly Roman, comments on life make the 16th century in a real sense the dawn of a new day. The spirit of the Renaissance, whether brought to Germany by Italians or acquired by Germans who resorted to Italian universities, broadens the outlook and confirms confidence in private judgment. Men mean to see with their own eyes. They become satirists and reformers. Johann Reuchlin (1454-1522) and DESIDERIUS ERASMUS (1466-1536), the *oculi Germaniae*, though neither followed Luther out of the Roman Catholic Church, were both, like him, impatient of repressive ecclesiasticism and, in their own ways, contributors to his Reformation. For the Reformation, supreme manifestation of German individualism, derived its ultimate sanction from humanistic or philological reliance upon personal interpretation of an authoritative original text.

In the literary history of Germany three generations of humanists are noteworthy for writings in Latin, or German, or both. Jakob Wimpfeling (1450-1528), clergyman, poet, father of German historiography and pedagogy, uses only Latin. Likewise Erasmus, who collects adages, inculcates rational conduct, composes an ironical *Encomium Moriae*, or "Praise of Folly," 1509, but also edits texts, among them the New Testament in Greek. Similarly Reuchlin, jurist, Hebraist, and, together with Erasmus, conspicuous for knowledge of Greek, writes in Latin a comedy, *Henno*, based upon the farce of *Maitre Pierre Pathelin*, sundry mystical treatises, grammars and dictionaries, and falls

back into his mother tongue only when engaged in a violent controversy over Hebrew. One Johannes Pfefferkorn, armed with an imperial rescript authorizing him to confiscate and destroy Hebrew books, attacked Reuchlin as a heretic and ignoramus. Dominicans at Cologne took Pfefferkorn's part; many humanists rallied to the defense of academic freedom; and in order to make the ecclesiastical party ridiculous, one humanist, Crotus Rubeanus (c. 1480-c. 1539), published under the title *Epistolae Obscurorum Virorum*, or "Letters of Obscure Men," 1515, in barbarous German-Latin what purported to be familiar correspondence of Reuchlin's adversaries, one of the most effective specimens of grotesque satire in European literature. A second volume, 1517, was the work of Ulrich von Hutten (1488-1523), an indefatigable agitator for political and religious freedom. Hutten develops prodigious facility in the composition of Latin addresses, exhortations, epigrams and dialogues, but, as his cause becomes more and more national, he translates his Latin into German and appeals to his fellow countrymen directly in German verses.

Of the generation before Hutten, Sebastian Brant (1457-1521), after trying his hand at divers *carmina*, gathers into his *Narrenschiff*, or "Ship of Fools," 1494, a sheaf of "characters" in German verse, each illustrated by a wood-cut. Brant's imitator, Thomas Murner (1475-1537), carries on in like manner with a *Narrenbeschwörung* ("Conjuration of Fools," 1512), a *Schelmenzunft* ("Guild of Rogues," 1512) and a *Geuchmat* ("Gawks' Meadow," 1519). Murner, a Franciscan friar, becomes the most prolific and redoubtable of the opponents of Luther. In a crude but forceful epic poem, *Vom grossen Lutherischen Narren* ("On the Great Lutheran Fool," 1520-22), he seeks to represent the cause of the Reformation as unprincipled, anarchistic and abhorrent.

MARTIN LUTHER (1483-1546), known even while a student as a musician and erudite philosopher, was endowed in no small measure with the qualities of a poet and plumed himself upon having taught his very enemies to speak and write. His translation of the entire Bible out of the original tongues into idiomatic German was the most potent determinant of literary usage for the future; his three dozen hymns gave an example and an impetus to innumerable followers; his fondness for the fable and the drama encouraged the use of these *genres* for edification or propaganda; and in sermons, treatises, prefaces, letters, invectives, disputations and table-talk he impressed his vigorous personality upon the Christian world.

The most amiable German writer of the 16th century is the shoemaker of Nuremberg, HANS SACHS (1494-1576), author of 6,200 compositions in verse and seven dialogues in prose. A substantial citizen of the most enlightened city in Germany, he fittingly represents the *bourgeois* spirit of the times. No scholar, he nevertheless had access to general literature in translations. Though devoted to Luther, he deprecated offensive partisanship. His prodigious output is partly accounted for by the fact that he often treated a single

subject in several different forms. By common consent he is at his best in *Schwanke*, or "jests," and *Fastnachtsspiele*, "shrove-tide plays"; for in these a restricted theme invites precision. He is naïf; the effects at which he aims call forth no psychological or other subtlety; but he knows how to articulate a narrative or, within limits, to conduct a plot; and his humor is as contagious as his benevolence is unmistakable.

Hans Sachs's dramas are not at all polemical. Neither is the *Susanna*, 1536, of Paul Rebhun (d. 1546), though the author is a Lutheran pastor. More characteristic of these controversial times are *Der Ablasskrämer* ("The Indulgence Peddler," 1525) of Nikolaus Manuel, the parable of the Prodigal Son (*Vom Verlorenen Sohn*, 1527) made to illustrate Luther's doctrine of justification by faith—this play the work of Burkhard Waldis, the most excellent fabulist of the century—and the *Pammachius*, 1538, of Thomas Kirchmair (Naogeorgus), translated from Latin into German by Justus Menius in 1539. In this piece the Pope, conceived as Antichrist, wages promiscuous warfare in league with Satan.

The outstanding author after the death of Hans Sachs is JOHANN FISCHART (c. 1540-90). The Roman Catholic Church has begun its counter-reformation, the Jesuits are active, invective is perhaps no fiercer and satire no more caustic than during the preceding generation, but a developed technique makes both more resourceful. Accordingly one finds Fischart reveling in inventiveness, not merely of subjects to ridicule, but also of a preposterous jargon which halts at no whimsy whatever. A disciple and translator of FRANÇOIS RABELAIS, he cultivates an artificial diction for its own sake, thereby cleaving the learned from the unlearned mass of the population, and marking the transition to an age of pseudo-classicism which extended to the middle of the 18th century.

Like the Great Interregnum of the 13th century, the Thirty Years' War of the 17th is one of the many breaks in continuity which we observe in German history, and the most devastating. Out of it comes, to be sure, Johann Jakob Christoffel von Grimmelshausen's *Simplicissimus*, 1669, a semi-autobiographical, realistic novel associable with Wolfram's *Parzival* in general design, but with a picaresque instead of a chivalric atmosphere. Despite the war, moreover, the stream of religious lyric poetry flowed on in both camps: Friedrich von Spee (1591-1635) was a Jesuit, Paul Gerhardt (1607-76) was a Lutheran pastor, Johann Scheffler ("Angelus Silesius," 1624-77) became a Catholic. But the war prevented the fructifying nationalization of humanism. Even Fischart had turned for guidance to France, and the leading men of the 17th century looked to France, Spain, or Italy for the means of replacing what had been destroyed in their own country. This century witnesses, then, conscious—in part collective—efforts to restore by legislating and imitating, often by imitating imitations.

The father of German "learned" poetry is MARTIN OPITZ (1597-1639). His little *Buch von der deutschen Poeterey*, or "Treatise on German Poetry," 1624, whole-

some as its doctrine was as to purity of vocabulary, natural accentuation, accurate rhyming, and strictness of construction according to the laws of the several kinds of poetry,—respectful, furthermore, though the writer was to the ancient classics—depended most upon secondary authorities: Scaliger, Ronsard, Du Bellay. It also had this fatal tendency: to encourage the belief that the art of poetry resides in the manipulation of diction. Some of Opitz's followers, such as Simon Dach (1605-59) and Paul Fleming (1609-40), occasionally allow one to forget this formalism; but not Andreas Gryphius (1616-64), the dramatist of the school; while the Marinism of the celebrated Christian Hofmann von Hofmannswaldau (1617-79) and Daniel Casper von Lohenstein (1635-83) remains, with whatever of baroque energy, an extravagant and grotesque bombast.

Eighteenth Century. A return to saner standards was brought to pass by efforts from two sides, the practice and critical pronouncements of poets, and a revised theory of poetry. Johann Christian Günther (1695-1723) managed to vitalize even the conventional forms; Friedrich Rudolf Ludwig von Canitz (1654-99), Christian Wernicke (1661-1725), and Benjamin Neukirch (1665-1729) paid homage, as Günther had done, not in vain to the reason and common sense of Boileau. To Boileau, likewise the last of the pseudo-classical theorists, Johann Christoph Gottsched (1700-66), a professor at Leipsic, listened attentively. What the Greeks were for the Romans, he said, that the French are for us. He exerted himself therefore to secure for Germany the regularity and decorum of the French drama. Being a capable organizer, he availed himself of various means of extending his influence, such as imitation of Addison's *Spectator*, the publication of periodical essays, treatises, translations; and in 1730 he laid down the law in a compendious *Kritische Dichtkunst für die Deutschen*, or "Critical Art of Poetry for the Germans." This law was salutary as a corrective, but was too moralistic and rationalistic. The law-giver, who for two decades affected to be a literary dictator, had no appreciation of Shakespeare or Milton; he demanded sobriety and verisimilitude; and poetic capacity meant for him little more than ingenuity, the imagination being a function of the wit.

About the middle of the century the position of the Leipsic dictator was rendered untenable by some defections from his own ranks, but chiefly by assaults, first from Zürich, presently from Berlin. The Swiss friends, Johann Jakob Bodmer (1698-1783) and Johann Jakob Breitinger (1701-76), read Addison to other purpose than Gottsched. To them the marvelous was more affecting than the self-evident; power to rouse the emotions was, they thought, the prerogative of an artist, and the imagination was a function of the inner eye. They found Shakespeare more dramatic than Racine, Milton the most picturesque of modern poets. The prophets of a new era stood with them, or they with the prophets: Alexander Gottlieb Baumgarten (1714-62), the founder of German aesthetics; Johann Joachim Winckelmann (1717-68), the Ger-

man founder of classical archaeology; Friedrich Gottlieb Klopstock (1724-1803), the ecstatic singer of the *Messias*; Moses Mendelssohn (1729-86), psychologist and philosopher; Christoph Martin Wieland (1733-1813), refined sensualist—and they would have been glad to make friends with Lessing.

It was GOTTHOLD EPHRAIM LESSING (1729-81) who gave the *coup de grâce* to Gottsched. The weapon which Lessing wielded was of the same kind as his, but of better temper; for Lessing went back to the ultimate classical authority in Aristotle, and plainly perceived, first, that the effects attributed to the drama must be expected, not from "regularity," but from causes actually moving; and secondly that alien *motifs* can be moving only if nationalized or otherwise brought home to spectators and readers. His practice illustrates this principle. His learning and enlightenment complete the transformation of pseudo-classicism into genuine classicism. But he confesses that he owes his productive power to industry guided by criticism, not to creative impulse.

Creative impulse, on the other hand, enthusiasm, the irrepressible urge to express personal emotion—these dominate the *Messias*, the *Odes* and the rhapsodical dramas of Klopstock. At a time when poetry was commonly denominated a "fine science" he was an indispensable witness to the truth that it is not altogether an affair of the head. To be sure, if Lessing was somewhat onesidedly intellectual, Klopstock was excessively sentimental. Were the Germans ever to attain to that "noble simplicity and calm grandeur" which Winckelmann predicated of Greek sculpture, they needed to harmonize discordant tendencies and achieve cooperation of the several faculties in a unified, integral personality.

Such was the ideal of Johann Georg Hamann (1730-88) and his voluble interpreter, JOHANN GOTTFRIED HERDER (1744-1803). Worship of this goddess looked at first like apostasy. The rising generation of "Storm and Stress" (Heinrich Wilhelm von Gerstenberg, 1737-1823, Heinrich Leopold Wagner, 1747-79, Friedrich Müller, 1749-1825, Jakob Michael Reinhold Lenz, 1751-92, Friedrich Maximilian Klinger, 1752-1831) led by Herder, gave free rein to their "genius," further encouraged thereto by Edward Young and by Rousseau. But Herder had been the pupil of Kant as well as the friend of Hamann, and as a philosopher he could venture to cope with Lessing. Though not so wise as his ancient prototype, Socrates, he was able to find for naturalness, instinctiveness, individual and national peculiarity, adequate sanction in a reasoned view of human evolution under the varying conditions of time and place.

The one great poet among the stormy and stressful has not yet been mentioned. In 1770 at Strassburg Herder met JOHANN WOLFGANG GOETHE (1749-1832). Herder's influence, deepened by other experiences, converted the rococo youth of Frankfurt and Leipsic into a pre-romantic: he luxuriated in the primitive, imitated the folksong, praised the German genius who built Strassburg cathedral, praised Dürer and Shake-

speare, and glorified genuine sentiment however expressed. There was exaggeration even in this hearty enthusiasm. Goethe needed a decade of self-discipline at Weimar and two years of sedative contact with antiquity in Italy before he could achieve that serene mastery of his powers and that grasp of reality which enabled him to reproduce nature with an art which he rightly defined as style.

JOHANN CHRISTOPH FRIEDRICH VON SCHILLER, whose active life began with revolt, whose passion was for morality, and to whose apprehension reality presented a lamentable contrast with the ideal, found his stabilizing principle in philosophy. Proceeding from Shaftesbury to Kant, he divined in beauty the perfect manifestation of goodness and truth, and so reconciled himself to life even in a world which science had made prosaic and Christianity had made melancholy. Henceforth, especially after he had gained the friendship of Goethe in 1794, his art was the deliberate objectivation of ideas, i.e., the endowment of facts and things with symbolical, transcendental significance. Art, he affirmed, is the peculiar possession of mankind; in it man demonstrates his freedom, and through it he transforms tragedy itself into a declaration of independence.

Nineteenth Century. The Romantic generation (see ROMANTICISM) which came to the front in the last years of the 18th century is, in respect to sovereign individualism, sentimental idiosyncrasy and esoteric diction, a continuator of Schiller; but after some personal friction it ignored him and lauded Goethe. There were two principal groups, with headquarters respectively at Berlin (or Jena) and at Heidelberg. The leaders of the first group, the brothers August Wilhelm and Friedrich Schlegel (see SCHLEGEL, THE BROTHERS) began as students of the ancients in the spirit of Winckelmann and Herder. Following Herder, with little or no acknowledgment, they soon turned from typically human to characteristic, national, personal art, and found in the picturesque symbolism of the Middle Ages their favorite examples of theme and method. Friedrich Schlegel (1772-1829) was the thinker, August Wilhelm the organizer, literary critic and historian who made practical application of the doctrine; the prolific Ludwig Tieck (1773-1853) its popularizer; the dreamy Friedrich von Hardenberg (Novalis, 1772-1801) the most poetic soul of the group; and Wilhelm Heinrich Wackenroder (1773-98) the most naïf enthusiast. Wackenroder's *Herzensergiessungen eines kunstliebenden Klosterbruders*, "Effusions from the Heart of an Art-loving Friar," 1797, fantastically preaching a coalescence of art and religion, was amplified and partially edited by Tieck, who is also to be credited with pushing through to completion a translation, begun by August Wilhelm Schlegel, of the plays of Shakespeare. This version so thoroughly naturalized Shakespeare that he is now more often seen on the German stage than anywhere else in the world.

At Heidelberg the movement assumed more and more the character of a Germanic renaissance. Lud-

wig Achim von Arnim (1781-1831) and Clemens Brentano (1778-1842) produced in *Des Knaben Wunderhorn*, "The Boy's Magic Horn," 1806-08, a fascinating anthology of popular songs. Their Hessian friends, Wilhelm and Jakob Grimm, outdid even this achievement in the universally known collection of *Märchen*, "Fairy Tales," 1812-15, and became the founders of the science of Germanic philology (see GRIMM, JAKOB and WILHELM). Comparable to the Grimms for scholarship, Ludwig Uhland (1787-1862) successfully echoed the popular tone in spirited ballads.

Germanic Romantic literature, being essentially subjective, was at its best in lyrical compositions. Joseph von Eichendorff (1788-1857) carried forward the impulse of the *Wunderhorn* in poems of love, minstrelsy, and nature—even in short stories interspersed with snatches of verse. So did HEINRICH HEINE (1797-1856), the writer in whom all phases of Romanticism may be discovered, not excepting "Romantic irony," and whose career epitomizes German literary history during the first half of the 19th century. Heine was the most popular lyric poet of his time. The most exquisite was Eduard Mörike (1804-75), whose humor is both more wholesome and subtler than Heine's wit; and next to the Protestant pastor Mörike a Roman Catholic poetess, Annette von Droste-Hülshoff (1797-1848), deserves to stand, for sincerity, simplicity and piety. In the middle of the century Emanuel Geibel (1815-84) enjoyed the greatest vogue as a singer of love. After him, though nothing could dam the flood of lyric utterance, authors of special distinction did not appear until recent times brought forth such men as STEFAN GEORGE (1868-) and RAINER MARIA RILKE (1875-1926).

The modern novel and short story follow the lead of Goethe. Romantic products in these *genres* are diffuse and formless, even the short stories of Mörike, and his *Maler Nolten* or "Nolten the Painter," 1832, a life history comparable to *Wilhelm Meister*. Exception must be made for the breathless narratives of Heinrich von Kleist (1777-1811), but he is altogether exceptional. Tieck did most to win favor for the short story on social subjects. Paul Heyse (1830-1914), the friend of Geibel, is his recent counterpart. In an episode, *Der Oberhof*, of a satirical novel, *Münchhausen*, 1839, Karl Immermann (1796-1840), the friend of Heine, set the fashion for stories, short or long, dealing with village life. The Oberhof is in Westphalia. Albert Bitzius ("Jeremias Gotthelf," 1797-1854), Gottfried Keller (1819-90), and Ernst Zahn (1868-) depicted life in Switzerland; Berthold Auerbach (1812-82) in the Black Forest; Adalbert Stifter (1805-68) in the Bohemian Forest; Fritz Reuter (1810-74) in Mecklenburg; Otto Ludwig (1813-65) in Thuringia; Theodor Storm (1817-88) and Gustav Frenssen (1863-) in Schleswig-Holstein; Theodor Fontane (1819-98) in Brandenburg; Peter Rosegger (1843-1918) in Styria; Clara Viebig (1860-) in the Eifel, Ludwig Thoma (1867-1921) in Bavaria; and Thomas Mann (1875-) employs a

similar method in *Buddenbrooks* (1902), the scene of which is the Hanseatic city of Lübeck.

The historical novel, owing much to the example of Walter Scott, was cultivated by Wilhelm Häring ("Wilibald Alexis," 1798-1871), Wilhelm Hauff (1802-27), Joseph Viktor von Scheffel (1826-86), Felix Dahn (1834-1912), and in special forms by Gustav Freytag (1816-95).

Beyond question, the most excellent German fiction of the century was written by the fellow townsmen of Zürich, Gottfried Keller and Conrad Ferdinand Meyer (1825-98)—the one a bluff, democratic, humorous, thorough-going realist who yet has a philosophy of life and knows the value of aesthetic discipline; the other aristocratic, aloof, producing—preferably on foreign subjects—works which Keller likened to brocade, so palpably elaborate is their texture.

The drama of the 19th century confronts us with successive endeavors to attain to greater specific gravity than was found in the idealistic plays of Schiller. Kleist, whose own life was charged with tragic intensity, dealt with extraordinary cases of cosmic, personal, or social disturbance of psychological equilibrium. His comedy, *Der zerbrochene Krug*, or "The Broken Pitcher," 1808, ranks next to Lessing's *Minna von Barnhelm*; and for impressively realistic presentation of characters confused as between legality and loyalty a like place belongs to his drama *Prinz Friedrich von Homburg*, published by Tieck in 1821. Franz Grillparzer (1791-1872), the Austrian Racine who similarly abhors the distraction that sensitive natures suffer from collision with the world, is a delicate delineator of feminine character, and writes poetic dramas, which are at the same time good acting plays, on subjects taken from remote Greek antiquity, from Austrian history and from the stores of his rich imagination. From him too we have a comedy, *Weh dem, der lügt!*—"Woe to the Liar," 1838. If to the three comedies above-mentioned we now add *Die Journalisten* ("The Journalists," 1852) by Freytag, we all but exhaust the list of German creations worthy to be mentioned in the same breath with Molière.

From Grillparzer's point of view Kleist and two other North-German dramatists, Friedrich Hebbel (1813-63) and Otto Ludwig (1813-65), are too much given to unesthetic contrivances. Hebbel is an ethical philosopher with a metaphysical cast, a sociologist who debates problems referred to the double aspect of all being, and who reveals the operation of centrifugal and centripetal forces in the evolution of personalities and institutions. But there is no denying his passion for truth, nor the cogent passionateness of his persons, though these be fully intelligible only as impelled by inexorable necessity. Ludwig, on the contrary, an amiable musician and born narrator, excogitates artificial plots, but remains unexcelled for the creation of atmosphere in individual scenes.

After the death of Hebbel and Ludwig the musical dramas of RICHARD WAGNER (1813-83) maintained and enhanced the dignity of the stage, and the troupe

of the Duke of Meiningen practised a stage craft comparable in idea to Wagner's conception of cooperative arts; but the spoken drama languished. When it revived, the theatrical technique of Dumas and Sardou, and the reproductive naturalism of Zola and Ibsen had dazzled the eyes of German admirers. The plays of HERMANN SUDERMANN (1857-1928) are a skilful combination of French inventiveness in intrigue and dialogue with Scandinavian or Zolaesque matter-of-factness. More representative of the revolutionists who clamored for a hearing at about the time when the young Emperor William was dismissing Bismarck, 1890, and when Friedrich Nietzsche (1844-1900) fervently advocated the making over of society in the image of superior individuality, was GERHART HAUPTMANN (1862-). His first successes were scored before a club dedicated to "consistent naturalism." But even in these pieces his dominant motive was self-expression. Readily, therefore, he turned to folklore and to themes from early German literature, and produced symbolical dramas in verse.

Modern German Literature. "Consistent naturalism" hardly survived the 19th century, which ended as it had begun under a Romantic constellation. HUGO VON HOFMANNSTHAL (1874-1929), is primarily lyrical in whatever he writes. Naturalism professed to mirror reality; impressionism—Alfred Mombert (1872-), Richard Dehmel (1863-1920)—confessed to individual reactions; "expressionism," the catchword of the second decade of the 20th century—Franz Werfel (1890-), Walter Hasenclever (1890-), Ernst Toller (1893-)—is a motto for a form of action, i.e., relief from the oppressiveness of a state of mind. The World War, inevitably asserting the eminent domain of the state over every individual possession, and incidentally creating situations enough which have not lacked literary treatment, seems but to have deepened the sense of the ancient verity that, after all, man is the measure of all things, and so to have given occasion for renewed multifarious self-assertion.

W. G. Ho.

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GERMAN SILVER or nickel silver is an alloy of nickel, copper and zinc. The composition varies but ordinarily about 50% is copper and the remainder nickel and zinc in about equal proportions. It is used in table-ware, in ornaments, and as a base for silver-plated ware. It is hard, takes a high polish but is attacked by weak acids.

GERMAN SOUTH-WEST AFRICA. See SOUTH-WEST AFRICA.

GERMANTOWN, a section of Philadelphia, Pa., incorporated in the 22nd ward of the city, but before 1854 a suburban borough, 5 mi. from the heart of Philadelphia. Germantown was settled in 1683 by Palatinate Germans under a grant from William Penn.

The first paper made in America was produced here about 1690, and the first Bible printed in the United States appeared in 1743. The Battle of Germantown was fought between the Americans and the English and Hessians on Oct. 4, 1777. Wissahickon Gorge and Chestnut Hill with its fine old houses and gardens make Germantown attractive. There is also a large manufacturing district.

GERMANTOWN, BATTLE OF, Oct. 4, 1777, an engagement of the REVOLUTIONARY WAR which resulted in a British victory. After the victory at Brandywine (see BRANDYWINE, BATTLE OF), the British army under Gen. Howe proceeded to Philadelphia, taking possession Sept. 25. While detachments to reduce American defenses on the Delaware and to escort supplies from the Chesapeake left only 9,000 troops in the main body at Germantown, a suburb of Philadelphia, Gen. Washington with 11,000 Continental troops assaulted the encampment. His plans were for separated divisions to march along converging lines and make a simultaneous attack at daybreak. But a dense fog enveloped Germantown, and a brigade under Gen. Stephen fired upon another American division under Wayne, breaking up the scheme of battle and causing the Americans to retreat. American losses totaled about 1,000; the British casualties were about half that figure.

GERMANY (*Deutschland*), sometimes the Germanies, in historical use the name applied to the collection of states forming, exclusive of Italy and Provence, the HOLY ROMAN EMPIRE; in modern usage the name applied to the former German Empire and modern German Republic (both *Das Deutsche Reich*) one of the great industrial nations of the world and the largest state of the continental peoples of Germanic speech.

Germany occupies the central portion of the great plain of northern Europe, having an extensive coast line on the Baltic Sea, a shorter one on the North Sea, a range of geologically ancient mountains, Harz and Bocksberg, in the center, and in the southwest reaching into the lower ranges of the Alps, where the Zugspitze, the highest mountain in Germany, attains an altitude of 9,738 ft. The Danish-German boundary on the north, and the Polish-German boundaries on the east in general follow the linguistic frontier, resulting in the discontiguity of German territory in the separation of East Prussia from the rest of Germany by the Polish Corridor. To the south the German boundary substantially follows that of the ancient Kingdom of Bohemia, almost unchanged in 1,000 years, along the bow of the Erzgebirge, and then from the vicinity of Passau on the Danube runs with Austria southwest and then west to Lake Constance and then with Switzerland substantially follows the Rhine to Basel. The linguistic frontier at few points corresponds with the political boundary, German speech extending into Czechoslovakia and Switzerland and embracing all of Austria. Small, isolated islands of German speech extend down the Danube and far out into southeastern Europe. The western

boundary with France follows the Rhine from Basel to Lauterburg and then bears west and north, touching Luxembourg, Belgium and Holland, crosses the Rhine above Arnheim and reaches the North Sea at the mouth of the Ems River. Except along the Rhine at no point does it follow natural geographical features and nowhere does it coincide with the linguistic frontier.

Drainage. The rainfall is generally heavier in western Germany and in the highlands, in many of these regions exceeding 30 in. annually, while three relatively dry pockets, averaging some 20 in., exist, the Rhenish Palatinate, the region along the Elbe between Halle and Magdeburg, and the Oder valley below Frankfurt-an-der-Oder. As a result of the high rainfall there are numerous lakes and some 150 rivers, of which seven are important streams, the Memel, Vistula (Weichsel), and Oder emptying into the Baltic, the Elbe, Weser and Rhine into the North Sea, and the Danube into the Black Sea. The Weser alone belongs entirely to Germany. The Memel (Polish *Niemn*) becomes navigable as it enters East Prussian territory and empties into the Kurische Haff. The Vistula is navigable before it reaches Germany, having many tributaries, and it divides into three arms, all flowing into the Baltic. The Oder is primarily a German river, flowing through the provinces of Silesia, Brandenburg and Pomerania, and emptying through three arms into the Baltic, after a large number of smaller rivers have united with it. The Elbe is navigable throughout its course in Germany. It originates in Bohemia and flows through Saxony, the Prussian province of Saxony, Anhalt, Brandenburg, Hanover, Mecklenburg, Hamburg and Schleswig-Holstein and flows into the North Sea at Cuxhaven. The Havel and Spree flow into it from the right, with other smaller rivers, while the Saale, Ilm and others are tributaries from the left. The navigable Weser flows mostly through Prussian territory, but touches Brunswick, Bremen and Oldenburg territories, and empties into the North Sea below Bremerhaven. The Rhine originates in the Swiss Alps, flows through Lake Constance, between Germany and Switzerland, then between Germany and Alsace, then is in German territory until it crosses the Dutch frontier. Its chief tributaries on the right side are the Neckar and the Main, and on the left the Ill, Mosel and Ahr. The Danube flows eastward from the South German Plateau through Bavaria and enters Austria at Passau. Its most important tributaries in Germany are, on the right, the Iller, Lech, Isar and Inn, and on the left, the Wörnitz, Altmühl, Naah and Regen.

Next to Sweden, Norway and Russia, no European country has so many lakes as Germany, where there are two distinct belts, one in the north and one in the south. The southern section stretches along the northern slope of the Alps and embraces about 70 lakes in Bavaria. The largest is Lake Constance (Bodensee) and the most beautiful the Königssee near Berchtesgaden. Among the larger lakes in the Bavarian Plateau and the Alps beyond are Starnberger-

see, Tegernsee, Schliersee, and Chiemsee. The northern lake zone surrounds the Baltic as far as Poland and contains an enormous number of lakes, there being 223 in the two Mecklenburgs alone. Besides these, there are a few other isolated lakes in various parts of the country. There are also very many mineral springs in the central mountainous sections of the country.

Climate. Northwestern Germany enjoys a climate oceanic in character, while the east tends to be continental with corresponding greater extremes of heat and cold. West of a line from Bremen to Stuttgart the average January temperature does not fall below freezing, while in East Prussia the mean temperature often reaches 22° F. The mean annual temperature of southwestern Germany, the Rhine and Danube basins, is about 52°-53° F., central Germany 46°-48° F., and in East Prussia 42°-44°. The mean January temperature varies between 22° at Masuren and 34° at Cologne, the mean July temperature, between 61° in Schleswig and 68° at Cologne. The extremes of heat and cold in ten years were 7° at Königsberg and 93° at Heidelberg, the warmest place in Germany.

Flora. The vegetation of Germany is fairly representative of that of all Europe lying north of the Alps and Carpathians and south of the Arctic Circle. The flora, which consists of both Baltic and Alpine plants, contains upwards of 2,500 species of flowering plants, more than 60 ferns and fernlike plants, and numerous mosses, liverworts, algae and fungi. The trees, rather limited as to variety, include several conifers, as pine, spruce, fir, larch, and yew, and various deciduous types, as birch, alder, beech, poplar, willow, elm, chestnut, hornbeam, maple and oak. Representative shrubs are hawthorn, medlar, cornel, sloe, broom and sweet gale. Among small bush plants are various fruit-bearing heaths, as the bilberry and cranberry, and several heathers, some of which in northern districts cover extensive sandy or swampy moors, called *Haiden*. The grasses, about 175 species, contain valuable kinds utilized for pasture and forage. The composites, represented by 330 species, differ characteristically from those of eastern North America in containing only seven species of aster and a single species of goldenrod. Among other herbaceous plants are numerous mints, primroses, forget-me-nots, buttercups, speedwells and gentians.

Fauna. The larger mammals, particularly the carnivorous ones, are rapidly becoming extinct. The bear has disappeared completely and the last aurochs or European bison was killed in East Prussia. A few mink linger in the northwest, as do the beaver on the Elbe and the lynx in the Alps. The wildcat persists in larger forests, and the wolf is not rare in northeastern Germany. The stag, the roe, the wild boar, the elk and the hare have been kept from extinction by stringent game laws. Fallow deer and rabbits have been introduced into Germany and have become wild in part. There are also many rodents and insect-eaters. Germany is rich in birds, especially song birds, which are largely migratory. Many of the

larger birds as the eagle-owl, the raven, the heron, and the black stork face extinction, but the white stork, the crane and the grouse have been protected. There are but few reptiles; these comprise 12 species of lizards and snakes and a single turtle. There are about 18 amphibians. Germany has about 60 kinds of fresh water fishes; the marine fishes include various valuable food fishes, as the herring.

Mineral Resources. The pre-war industrial position of Germany was based upon the possession of the coal mines of the Ruhr, Saar and Silesia and the iron ores of German Lorraine. The cession of territory under the Treaty of Versailles and the change of Luxembourg from the German to the Belgian customs union, removed from the German customs union 43% of the pig iron production, 35% of the ingot steel production, 37% of the steel mill capacity and 31% of the steel fabricating mill capacity. As a result of the loss of the Lorraine ores from which Germany drew three-quarters of her iron, to maintain the 57% remaining of her pig iron production requires the importation of substantially as much ore as was imported in 1913. This alteration of the domestic coal and iron balance, the chief basis of modern heavy industry, has had an important effect on the post-war disturbances of German economic life. The remaining German iron mines lie chiefly in Hanover. In addition to the commercially worked coal mines great deposits of "brown coal," varying from low grade bituminous to lignite, extend widely over northern and central Germany but are not of very great commercial use at the present. In comparison with its needs, Germany is very poor in other ores. Gold is merely a by-product of the smelting of foreign ores. Silver is also no longer mined, as in earlier times, when Germany was the first silver country. Since the loss of Upper Silesia, zinc, reduced to one-fifth of the pre-war volume, is mined almost entirely on the Rhine. Lead is mined to a small extent, and copper, an insignificant quantity in the world total, mainly in Mansfield. Aluminum production has increased enormously and now exceeds one-quarter of the European total.

The situation in regard to domestic ores is such that there is not enough of any metal to satisfy the demand. Of much greater importance—with the exception of coal—are the mineral salt mines, principally potash, the output of which is consumed to a considerable extent in Germany and is also a highly important article of export, large quantities reaching the United States mostly as fertilizers. The principal mines are in central Germany around Stassfurt, Halle, Schönebeck, Brunswick, and, of late, also in Baden. In the artificial production of minerals, phosphates, nitrates and oil, Germany occupies, on the whole, a favorable position. The production of synthetic phosphates, a by-product of iron smelting, has been reduced two-thirds by the loss of Lorraine, but the manufacture of synthetic nitrogen has grown to more than three and a half times its 1913 volume while the production of synthetic gasoline by the

hydrogenation of coal, a German invention and German monopoly in Europe, is a matter of the greatest industrial promise. Some natural oil has recently been found in northern Prussia, but it does not give promise of being in quantities great enough to supply the domestic demand.

Agriculture. In garden vegetables, and in all the cereals but wheat, German agriculture supplies most of the country's needs. Domestic wheat, which is grown in the northwest and the highlands of central and southwestern Germany, in pre-war conditions supplied more than two-thirds of Germany's needs, but since the war wheat imports are greater than 50% of the domestic supply. This has been caused by a decline in production to 65% in the present area and an increase in wheat consumption at the expense of rye. Production of rye, barley and oats has similarly declined, but none so much as to force considerable importation. Germany, which before the war stood first in the production of potatoes, now takes second place to Russia, but is not forced to import. In all these agricultural products not only has the total production declined from the pre-war standard, but in every case the yield per acre has shrunk, sometimes sharply, despite a 40% increase in the use of chemical fertilizers by the country as a whole. The yield, however, is still much higher than in countries practicing extensive agriculture like Canada and the United States, and is nearly double the German yield of a century ago.

Concomitant with the decline in grain production has been an increase of milling facilities abroad, with the result that flour imports have increased greatly. The growing of sugar beets is restricted to the country around the Harz Mountains and the state of Anhalt, the Prussian province of Saxony and a few other districts. Competition with cane sugar and international agreements has decreased the German production of beet-sugar by one-half, but Germany is still the greatest beet-sugar producer. Hops are grown principally in Bavaria, and also in part of northern Germany. A little tobacco is grown in southwestern Germany, but it is of trifling importance in comparison with the tobacco imported. Production of flax, hemp and wine have all declined. Germany is obliged to import much fruit, though the number of her fruit trees is rapidly increasing. In the North German Plain, the environs of Berlin and Leipzig and also further south, vegetable growing is highly developed, one of its finest products being the Brunswick asparagus. Erfurt and Quedlinburg raise flowers on a commercial scale and export seed. Agricultural lands occupy 56.6% of the area of the country.

In the live stock industry Germany was never a producer for export. Cattle raising is carried on in the higher central and southern regions, but in modern times has never equalled the domestic demand. Eight times the domestic wool production was imported in the pre-war years, but with the decline of domestic consumption and export of piece goods, imports have

GERMANY



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SCENES IN GERMAN CITIES

1. A view of the harbor of Hamburg, showing transatlantic steamers on the northern arm of the Elbe. 2. The Reichsgericht, or Federal Supreme Court, at Leipzig. 3. Aachen's Rathaus or City Hall. 4. Battle of the Nations Monument, Leipzig.

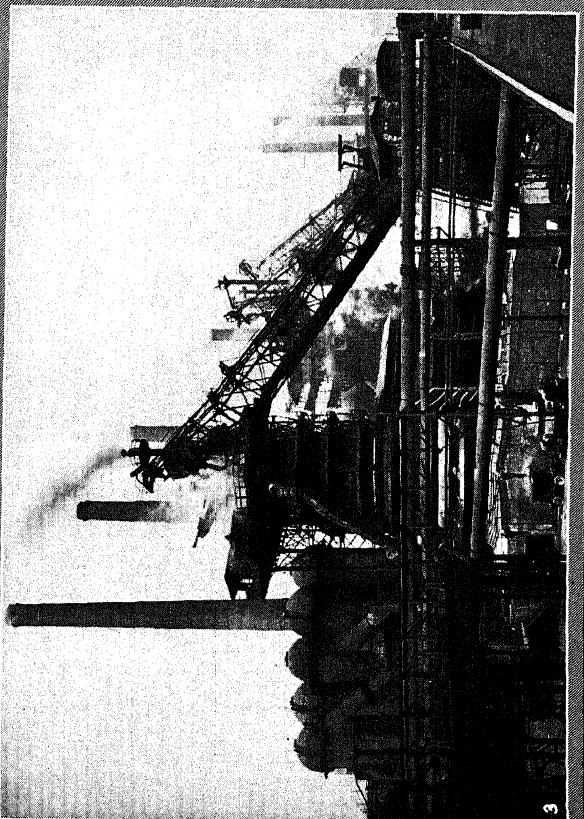
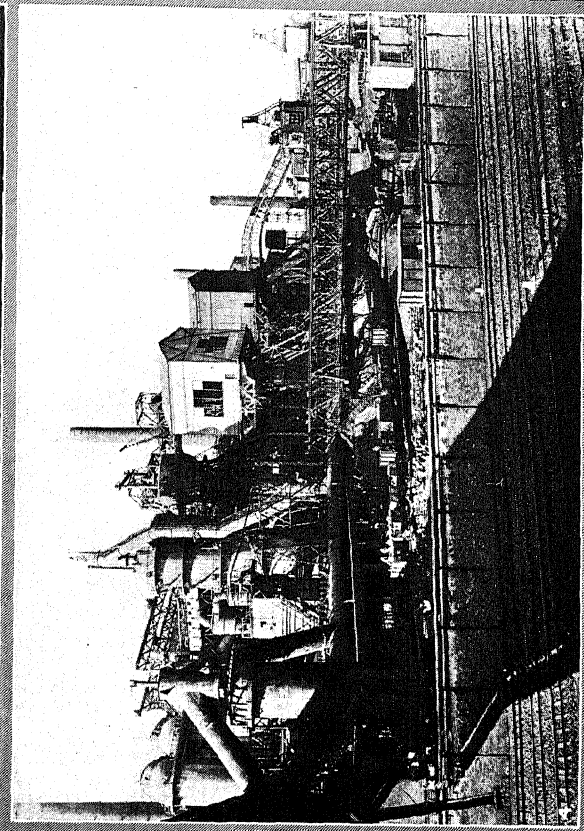
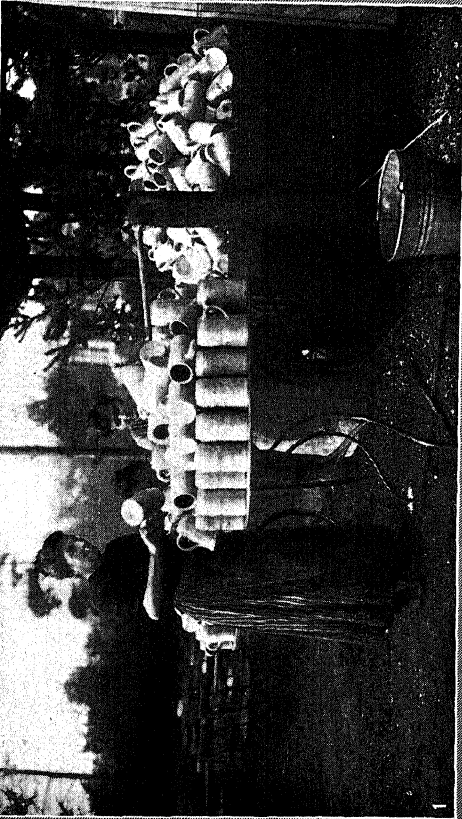
GERMANY



SCENERY ALONG THE STORIED RHINE

1. The Castle of Stolzenfels, 505 ft. above the Rhine.
2. The Neu-Katzenelnbogen, or "Cat Castle," above Saint Goarshausen.
3. The medieval Rheinstein Castle near Bingen.
4. Pfalz Castle, near Kaub, commemorating Blücher's victory in 1813.

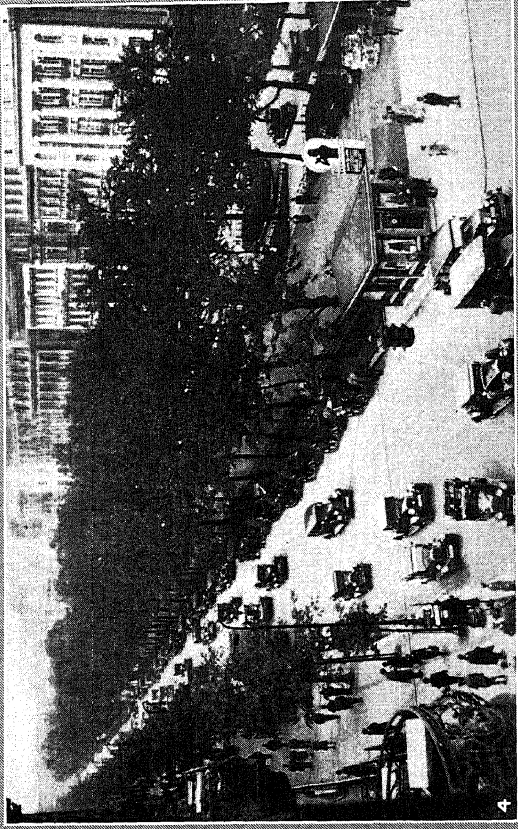
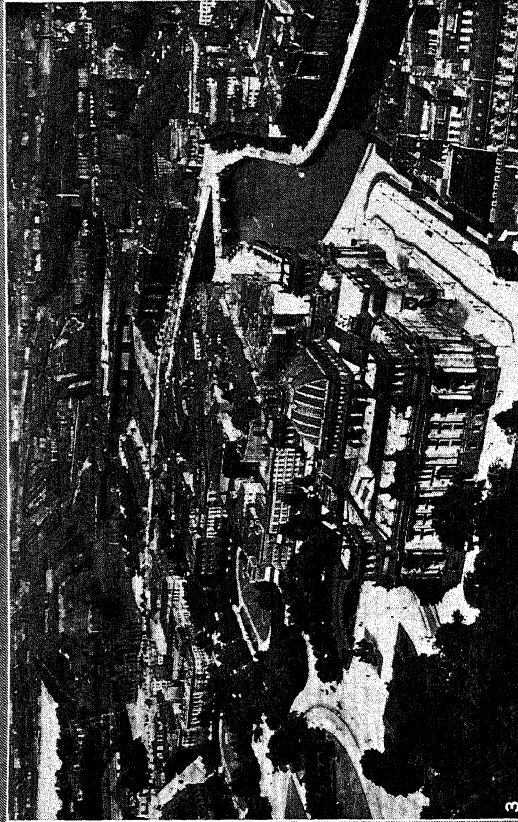
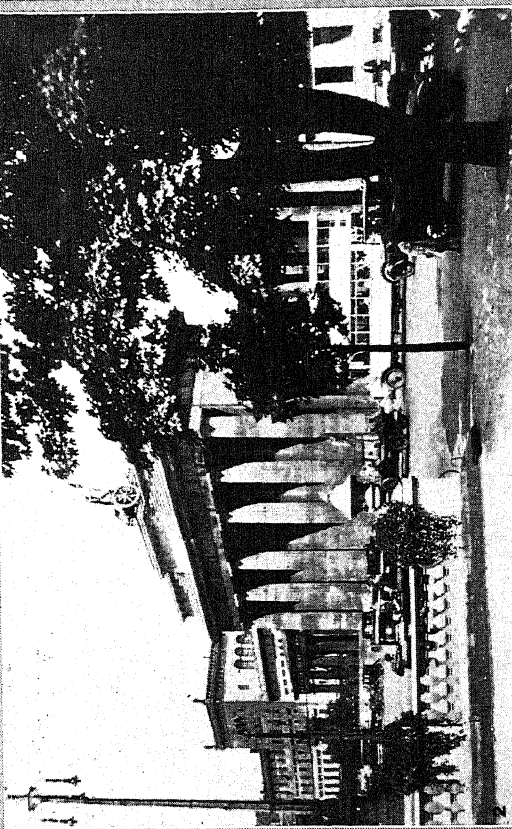
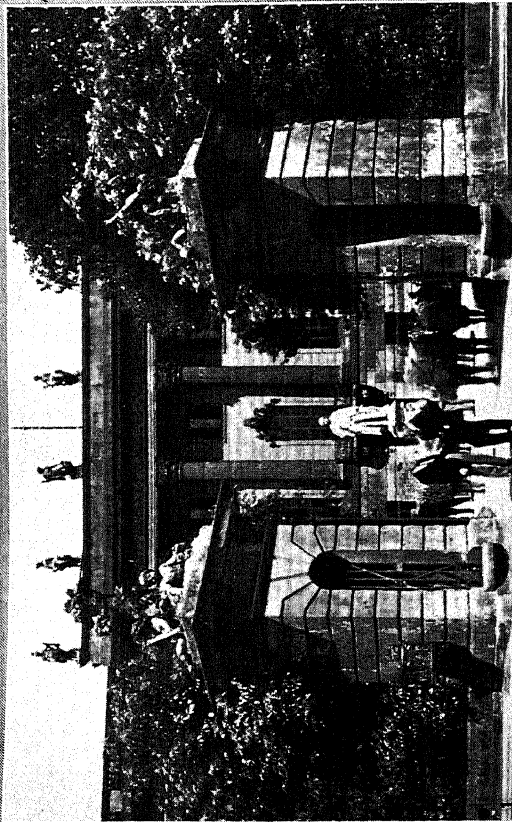
GERMANY



GERMANY AT WORK AND PLAY

1. The Bavarian "October Festival," held yearly at Munich.
2. The Bavarian native folk dancers in holiday costume.
3. A "Hobewerk," or furnace-feeding elevator, in an industrial plant.
4. Extensive smelting works at Dortmund in the Ruhr.

GERMANY



BERLIN—POLITICAL AND INTELLECTUAL CENTER OF GERMANY

1. Friedrich Wilhelm University: the Unter den Linden entrance. 2. The Brandenburg gate as seen from the famous Tiergarten.
3. Panorama of Berlin showing the Reichstag building in foreground. 4. The beautiful Unter den Linden, a world-famous avenue.

GERMANY

Area 181,662 sq. m.
Pop. . . . 64,600,000

PRINCIPAL CITIES

(Including Figures from Latest Population Estimates)

Pop.—Thousands

156 Aachen (Aix la Chapelle) . . . K 2
234 Altona . . . D 7
168 Augsburg . . . P 8
191 Barmen . . . P 8
4336 Berlin . . . G 13
94 Bielefeld . . . K 20
91 Bielefeld . . . H 5
323 Bochum . . . I 3
93 Bonn . . . J 3
151 Braunschweig . . . G 8

306 Bremen . . . F 6
617 Breslau . . . J 17
Brunswick, see Braunschweig.
Carlsruhe, see Karlsruhe.
Cassel, see Kassel.

353 Charlottenburg . . . G 12
361 Chemnitz K 11
Coblenz, see Koblenz.
Cologne, see Köln.
Crefeld, see Krefeld.

70 Darmstadt . . . M 5
77 Dessau . . . H 10
535 Dortmund . . . I 4
633 Dresden . . . J 13
441 Duisburg . . . I 3
477 Düsseldorf . . . J 3
173 Elberfeld . . . J 3
140 Erfurt . . . J 9
649 Essen . . . I 3
541 Frankfurt . . . I 3
92 Freiburg . . . Q 3
77 Fürt . . . N 3
336 Gelsenkirchen . . . I 3

83 Gera . . . K 10
194 Gladbach . . . I 2
106 Gleiwitz . . . L 20
92 Götting . . . J 14
101 Hagen . . . I 4
202 Halle . . . J 10
129 Hamburg . . . I 2
1148 Hamburg D 8
443 Hannover . . . G 6
83 Heidelberg . . . N 4
152 Karlsruhe . . . O 4
175 Kassel . . . I 6
218 Kiel . . . C 8
740 Köln . . . J 3
295 Königsberg . . . B 22

159 Krefeld . . . I 2
700 Leipzig . . . J 10
128 Lübeck . . . D 8
106 Ludwigshafen . . . M 4

299 Magdeburg

111 Mainz . . . L 4
272 Mannheim M 5
131 Mülheim . . . I 2
730 München (Munich) . . . Q 9
116 Münster . . . H 4
417 Nürnberg . . . N 9
110 Oberhausen . . . I 3
82 Offenbach . . . L 5
94 Osnabrück . . . G 5
79 Pforzheim . . . O 5
113 Planen . . . I 10
87 Recklinghausen . . . I 3

81 Regensburg . . . O 10
79 Remscheid . . . J 3
76 Rostock . . . C 10
270 Stettin . . . E 13
377 Stuttgart . . . O 5
154 Wiesbaden . . . L 5
406 Wuppertal . . . J 3
93 Würzburg . . . M 7
87 Zwickau . . . K 11

DANZIG

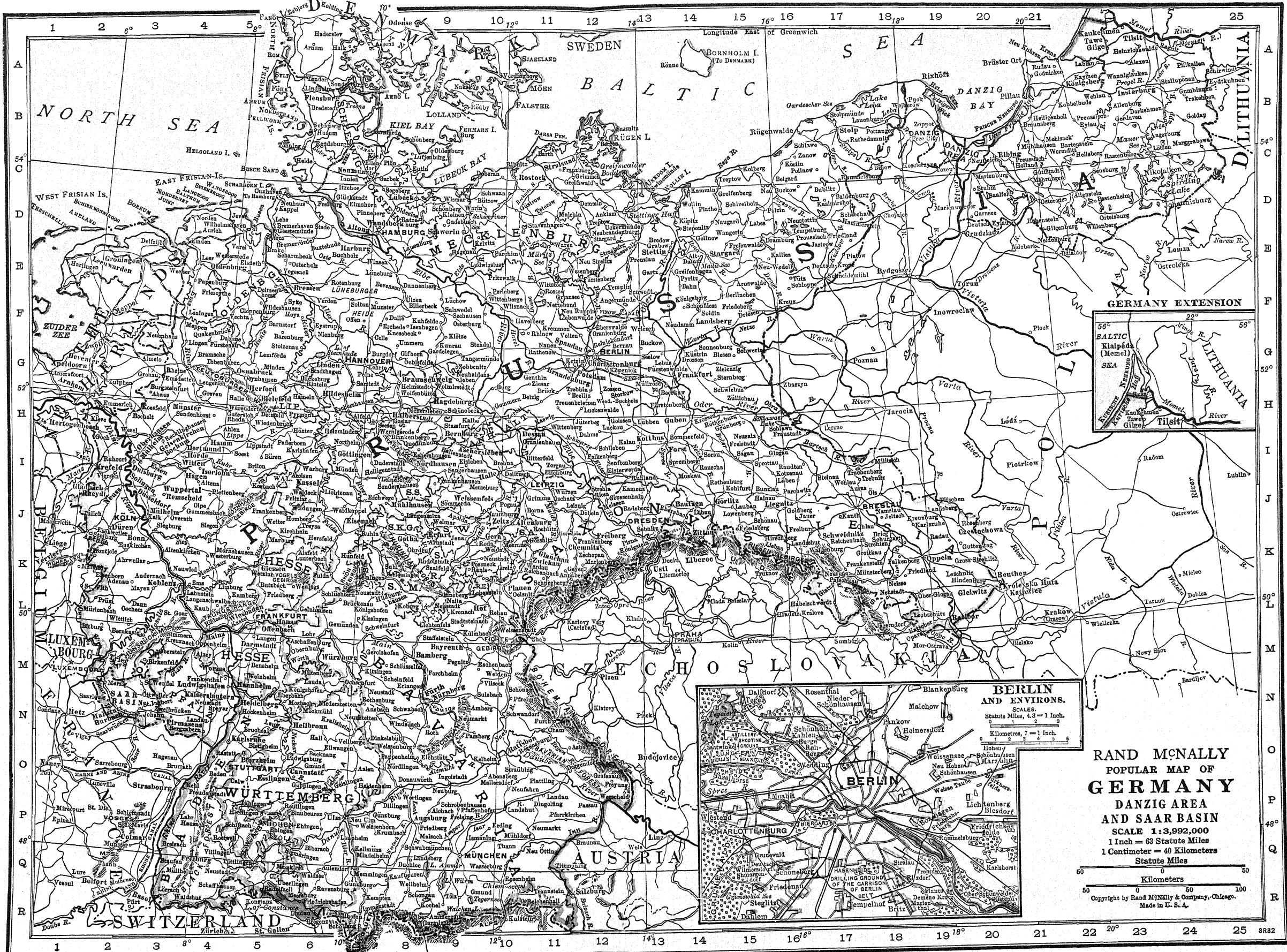
Area . . . 754 sq. m.
Pop. . . . 407,517

PRINCIPAL CITIES

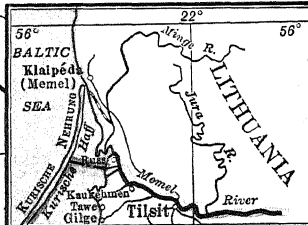
(Including Figures from Latest Population Estimates)

Pop.—Thousands

235 Danzig . . . C 19
(Free City)
28 Zoppot . . . B 19



GERMANY EXTENSION



BERLIN AND ENVIRONS.

Scale: Statute Miles, 4.3 = 1 Inch.
Kilometers, 7 = 1 Inch.

RAND McNALLY
POPULAR MAP OF
GERMANY
DANZIG AREA
AND SAAR BASIN
SCALE 1:3,992,000
1 Inch = 63 Statute Miles
1 Centimeter = 40 Kilometers
Statute Miles

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shrunk more than domestic raw wool production, which is now more than one-sixth of the imports. The raising of hogs, which in pre-war years substantially supplied the domestic demand, suffered a severe decline for some time, bringing about importation of lard and pork products, but has recently begun to improve.

Forests. The primeval forests of Germany covered almost the entire country and, except in the northeast, were predominantly of deciduous hardwoods. Today some 26.3% of the area of the country is occupied by forests in various stages of growth, but the great forests of the northern plains have given way before agriculture and industry, and four-fifths of the present woodlands lie in the mountains. Following a policy of commercial reforestation evergreens have been planted in place of the former hardwoods and the latter now amount to but one-third of the forest area. Under the Treaty of Versailles Germany was forced to make heavy reparation deliveries of lumber, with the result that vast tracts of forest were prematurely cut and the former proportion of domestic demands for lumber cannot be met by the German forests for more than a generation. Correspondingly the charcoal, wood tar and rosin industries have declined.

Fisheries. The formerly important inland fisheries have greatly declined, owing to the polluting of the river water by industrial plants and large cities, and by the heavy traffic which the rivers now carry. Trout are numerous in the central and southern mountain streams and the lakes, particularly Lake Constance, and efforts are being made to stock the lakes and brooks. More important than the fresh water fish are the sea fisheries, which are located as far away as Iceland and the Murman coast. The trawlers are specially constructed vessels, using radio, weather reports and refrigeration. The fishing is carried on mainly from ports on the Weser and the lower Elbe. The catch is insufficient, however, and Germany imports large quantities of sea fish.

Although Leipzig is one of the most important fur markets of the world, the pelts are practically all of foreign origin, except for the furs from animal farms.

Industry. Germany is the largest European producer of iron, steel, electrical machinery, dyes, nitrates and potash, the largest European consumer of copper and aluminum, and in Europe is second only to Great Britain in the production of machine tools and in ship-building. In the textile industries, however, she ranks below both Great Britain and France. The supporting domestic industries of building, food products, wood and paper, leather, and the utilization of hydroelectric power are correspondingly large. In certain industrial lines, such as precision instruments and tools, difficult castings, and optical instruments, although the output is not large in comparison with the heavy industries, the high quality of the German products gives them an important share of the world markets. In normal times the industrial workers of

Germany number some ten million, living in four principal centers, the lower Rhine from Coblenz to the Dutch border (including the Ruhr), the vicinity of Hamburg, the vicinity of Berlin, and Saxony. Smaller groups of industrial workers live in the principal cities and in the mining region of Silesia. This distribution of industry is in part accounted for by natural causes. Industrial enterprises are near coal mines, as on the lower Rhine and its tributaries, and here transportation facilities are also significant. Sugar factories and distilleries must be near their sources of supplies and markets and, with most of the great iron works, are in the Ruhr district. The chemical industry receives high prices for small weight; thus the freight is negligible, and many factories are in remoter districts on railroads or rivers. Saxony and East Thuringia are noted for woolen and cotton goods, Silesia and the Bielefeld district for linen, Crefeld and its surroundings for silk goods, Barmen for ribbons. Since the World War Germany has grown still further into the machine age, and her inventors are steadily making improvements in many lines.

Communications. Germany's progress as an industrial nation before the World War necessitated adequate means of communication. Railroads and waterways lead beyond the German boundaries, and the network of canals is now being further augmented. The Dortmund-Ems Canal has opened a way through German territory for smaller ships from the Rhine to the North Sea. The Mittelland Canal, which has reached as far west as Hanover, will unite the Rhine and Elbe systems, the Rhenish-Westphalian and the central German industrial region. Two and a half centuries ago the Oder was united with the Elbe and later by the modest Elbe-Trave Canal. Of greater importance is the waterway for large ships between Berlin and Stettin. The flat lands of north Germany are better off in regard to waterways than the central mountains and the south. The chief plans of the Reich with regard to south Germany are to continue the Neckar via Heilbronn to Cannstatt and to effect a considerable widening and improving of the present channels between Rhine, Main and Danube. Passenger steamers ply on the Rhine from Mainz to Cologne, on the Moselle from Trier to Coblenz, on the Elbe from Dresden up-stream to Leitmeritz, Bohemia, and down-stream from Meissen to Muhlberg, and on the Weser from Munden to Hamelin.

According to the provisions of the Treaty of Versailles, Germany lost most of its mercantile marine, amounting to 92% of its total tonnage. Besides, Germany is bound to build ships for its former enemies and to provide extensive harbor facilities for them. Though its net tonnage decreased to 1% of the world merchant marine tonnage, Germany made heroic efforts and by 1924 had reached the eighth place among the shipping nations.

The density of Germany's network of railway is surpassed only by Belgium and England, and the

roads carry much more freight than the interior waterways. The mileage exceeds that of any European country. About 120 railways cross into foreign countries, 47 to Poland, 32 to Czechoslovakia and only eight to Austria. The electrification of the railroads has made steady progress, especially in central and southern Germany. Trains are conveyed on ferries to Denmark and Sweden. In Apr. 1920, the railroads of the several states became the German Reich Railway (*Reichsbahn*) under the German Reichsbahn-Gesellschaft, an independent company formed under the Dawes Agreement, with German administration and interallied supervision.

Roads in Germany have been excellent for years and did not need the stimulus of motor car traffic, though the latter has increased greatly, having quadrupled since 1921. However, Germany is still far behind other nations in the use of automotive vehicles.

Her principal seaports are on the North Sea at the mouths of the Elbe, Weser and Ems, Hamburg-Altona, Bremen with Bremerhaven and Wesermünde, in which cities the great shipping companies are located.

Despite the restrictions imposed by the Allies, Germany has made progress in aerial communication and has reached probably first place in commercial aviation. There are more than 30 flying fields and as many trips daily to cities in Germany and beyond. Military planes are prohibited by the peace treaty. The Reich's government-operated postal, telegraph and telephone department now serves the entire country, since the local services of some of the larger states have been abolished. The department functions as an independent enterprise like the *Reichsbahn*. The number of phones is insignificant from an American point of view. All German transoceanic cables were taken under the Versailles Treaty.

Commerce. Germany's trade had increased with leaps and bounds before the World War, having surpassed that of France and approached that of Great Britain, but it was gravely injured by the provisions of the peace treaty. Foreign trade soon sunk to one-half of the business in 1913, and the increasing imports and decreasing exports worked havoc. Restrictions against German goods and the loss of foreign connections were largely responsible. The chief exports are manufactured goods and the chief imports raw materials and food products.

Germany's best post-war customer is Great Britain, likewise her best pre-war customer, but her sales to Great Britain declined from 14.2% of her total imports in 1913 to 10.7% in 1925, a normal year. Where before the war Germany purchased 8.1% of her imports from Great Britain and 15.9% from the United States, in 1925 she purchased but 7.6% from Great Britain and 17.7% from the United States. Commerce with Russia, which in pre-war years made Russia Germany's second greatest customer and second greatest source of imports, has dwindled greatly despite a determined attempt by the Reich government to

encourage exports to Russia by trade and financial assistance. The abnormal financial conditions of 1930-31 entirely upset the balance of German industry, both domestic and foreign; the former import balance which had lasted through 1928 and the trifling export balance of 1929 were converted into tremendous export balances, but largely unprofitable ones accompanied by an almost exactly equivalent withdrawal of foreign capital. The domestic situation brought on widespread unemployment with the result that the dole was forced to carry some 15 million persons during the closing months of 1931.

Finance. The monetary unit is the Reichsmark (\$0.238) and the Rentenmark, both at 100 pfenning. Reichbank notes and Rentenmark certificates are issued at 1,000 RM and downward. The largest coin is 5 RM. The Reich's receipts decreased in 1931 both in comparison to the previous months and to corresponding periods of 1930, the decline being due to the falling off of taxes and customs receipts. The expenditures of the regular budget were also relatively small in comparison with previous periods, owing to smaller appropriations for government employment agencies and unemployment insurance. The extraordinary budget showed in the summer of 1931, including the amounts of the previous year, a very heavy deficit.

Defense. The Treaty of Versailles reduced the German army to 100,000 men, including 4,000 officers, and forbade the use of heavy artillery, tanks and airplanes and barred the maintenance of reserves. Military training is forbidden in schools and in all sport and other clubs, but a semi-military police force, the Heimwehr of unknown fighting strength, has been developed. Of the fortresses, only those on the eastern and southern frontier may be maintained. The number and character of the arms are prescribed, and a commission of officers of the former Allies is provided to see that the regulations are enforced. The navy is restricted to six commissioned battleships of not more than 10,000 tons displacement nor armed with greater than 11" guns, and two such ships in reserve, six cruisers and 18 destroyers and a few pre-war ships of doubtful fighting value. Hemmed by the restrictions placed upon battleships, the German naval architects have designed the *Deutschland*, placed in commission in 1932, to obtain the maximum fighting efficiency under these restrictions. The *Deutschland* is armed with 11" guns of the extraordinary range of 30,000 yards; she has a speed of over 30 knots, and by the extensive use of welding and aluminum, a fast, powerful, armored craft has been produced at less than 10,000 tons displacement. The repercussions of this feat in the naval offices of the world have been considerable, and may force other navies to build similar ships. The personnel of the German navy, officers and men, is restricted to 15,000. Submarines are forbidden.

Religion. About 65.2% of the population of the German Reich are Protestants, 33.1% Roman Catholics, 0.9% Jews and 0.8% belonging to other religious

bodies or to none. The majority of the Catholics live in eastern, southern and western Germany, while the north and center of the Reich are predominantly Protestant. The Reformed churches in the various states are governed by presbyteries, and the Lutheran churches by commissions or individuals with the title of bishop or, particularly in Prussia, of superintendent-general. The Roman Catholic Church has four archbishoprics in Germany: Cologne, Munich-Freising, Bamberg and Freiburg in Breisgau. There are 18 bishoprics, of which four are "exempt," i.e., directly under the Pope: Ermeland, Breslau, Hildesheim and Osnabrück. The Old Catholics have a bishop in Bonn recognized officially, except in Bavaria. The Jews, with few exceptions, live in the large cities; their number has increased since the war from the immigration of eastern Jews.

Government. According to the Constitution adopted in Weimar, Aug. 11, 1919, the German Reich is a Federal republic of 17 states (*Länder*) the power being vested in the people. The constitution avoids the issue as to whether the Reich is a federation of states or a single state, but the tendency is towards centralization. Every state must have a republican constitution and allow universal suffrage of all citizens of both sexes over 20 years old. Either the government of the Reich or one-third of the voting population may initiate legislation and demand a referendum. In disputes between the Reich and the states, among the several states, and in constitutional matters the questions may be settled by the State Court of the Reich and the Reich's President enforces the decision. In affairs of the Reich, the power is held by the Reich's President, the Reichstag and the Reichsrat. The laws of the Reich are paramount, and any state laws in contradiction thereto are invalid. The Reich's President is elected directly by the people for a term of seven years. The candidate receiving more than half the votes cast is elected and reelection is admissible. He can be deposed by a popular referendum and also be impeached on demand of 100 or more deputies of the Reichstag. The Reich's President has greater power than the President of France and less than that of the President of the United States. The members of the Reichstag are elected for terms of four years and correspond to the United States House of Representatives. The Reichsrat is composed of representatives of the various states and thus corresponds to the United States Senate, except that the number of members of each state is determined by the population. Prussia has 26 members and the other states less, the ten smallest having but one member each. The provisional Reich's Economic Council has the right to recommend legislation and to issue reports on economic questions. The Chancellor and the ministers are dependent upon the support of the Reichstag, as in the case of the British and other parliamentary governments. The Empire's legal code is used with minor changes.

Population. The latest German census was taken in 1925, when the population of the Reich, excluding

the Saar, was 62,410,619. Of this number Prussia, excluding the Saar and including Waldeck, had 38,175,989; Bavaria, 7,379,594; Saxony, 4,992,320; Württemberg, 2,580,235 and Baden, 2,312,462. The phenomenal growth has been in the industrial centers. The largest German cities in 1925 were Berlin, 4,024,165; Hamburg, 1,079,126; Cologne, 700,222; Munich, 680,704; Leipzig, 679,159; Dresden, 619,157. The pre-war area was 208,830 sq. mi. and the present area is 181,714 sq. mi. See separate articles on these cities.

Ethnology. The Germans no more constitute a race, in the sense of a group of persons all descended from common ancestors who were themselves of an identical type, than do the peoples of any other great nation. Even the different ancestral groups from which the present population is descended is a subject of dispute among anthropologists. It seems probable that the Germans are descended from Keltic, Germanic and Slavic speaking ancestors, but the racial constitution of these groups is entirely unknown. These three groups have, however, mixed among themselves, and unless the Germans of the times of the migrations were already a mixture, and their descendants therefore unrecognizable from the descendants of subsequent mixtures, a relatively pure Germanic type exists only among the isolated Frisians of the extreme northwest. The physical type of the population varies greatly with the locality. In the north, tall, blond, long-headed persons, commonly described as the Teutonic type, predominate, while in the south the Alpine type, stockier, darker-haired and pronouncedly more round-headed predominates. The population, however, is 99% German speaking. The German birth rate which in the period 1905-08 stood at 34.7 has, along with that of all the industrial countries, declined in recent years and in 1928 reached 18.6. In the same period, however, the death rate declined, though not so rapidly, so that the excess of births over deaths has been gradually declining. In the period 1901-04 it stood at 11.6 per 1,000 inhabitants, 1920-24 at 9.2, and in 1928 at 7.0.

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GERMANY, HISTORY OF. The geographic area known as Central Europe was peopled in ancient times by lake-dwellers, men who sought protection against human and animal enemies by building their abodes in the water. Most of what we know about the life and customs of these early inhabitants has been revealed by relics found in thousands of lake-dwellers' graves. Living first in the more northerly parts of Central Europe, the barbarians gradually moved southward, fleeing alike from an overflow of the Baltic and from the human hordes that poured into Europe from the East. Eventually these "Germans" came into contact with the Romans, and Caesar, Strabo, Pliny and Tacitus have left interesting accounts of the invaders. Naturally much of the contact between Germans and Romans was of a

military nature, with the Romans enjoying a superiority in weapons, strategy and experience. In 102 B.C. and 101 B.C., respectively, GAIUS MARIUS inflicted crushing defeats upon the Teutones in southern Gaul and the Cimbri in northern Italy. JULIUS CAESAR, in 58 B.C., defeated the Suevian King, Ariovistus, thus driving the Germans out of Gaul and back across the Rhine. A temporary change of fortune occurred in 9 A.D., when Hermann the Cheruscan (*see* ARMINIUS) destroyed the legions under Varus in the Teutoburg Forest. Germanicus, however, avenged this loss during the reign of Tiberius, and for some time thereafter the territorial integrity of Rome was not seriously threatened by the Germans. Then, in the latter half of the 2nd century the Marcomanni caused considerable annoyance to the Romans, though they failed to upset the equanimity of the Stoic Emperor MARCUS AURELIUS who composed his *Meditations* in the midst of the war against this people. Finally, from the 3rd to the 6th centuries, the so-called Germanic Invasions, during the course of which the decadent Roman Empire was overrun by barbarians, took place. Eight Teutonic kingdoms were formed out of the former Roman provinces, in the 5th and 6th centuries. One of these kingdoms, established in 511 by Clovis I, the first of the Merovingians, included the lands which later were to be known as France and Germany. Here the Germans and Romans intermingled and intermarried. The Germans absorbed Christianity and a certain amount of Roman culture. The Romans benefited by the infusion of vigorous, healthy blood. Gradually a feudal society evolved.

After the death of Dagobert in 638, the Merovingian rulers rapidly degenerated, eventually coming to be known as the "do-nothing kings." They were utterly incapable of governing the huge kingdom which encompassed regions on both sides of the Rhine. Quarrels between local chieftains and nobles, and the imminent Moorish peril, bade fair to create anarchy anew. By the end of the 7th century, however, the energetic Carolingian family had secured hereditary control of the important office of Mayor of the Palace. In the next century Pepin the Short (*see* PEPIN III), whose father, Charles Martel, had decisively defeated the Moors in 732, placed the last Merovingian king in a monastery and had himself elected King of the Franks, 751. Pepin and his son, later famous as Charles the Great (*see* CHARLEMAGNE), consolidated the family's power and battled heroically with the Bavarians, Saxons, Thuringians and Lombards.

Partition of Charlemagne's Empire. In 768 Charles became King. After a successful war in Italy he had himself chosen Emperor by the Romans and crowned by the pope on Christmas Day, 800. He built up a huge empire, spent much of his time fighting rebels and invaders from Saxony to Spain, instituted an efficient system of administration, fostered a number of the practical arts, and bequeathed a most difficult task of government to his son Louis

THE PROUS, 814-843. Civil wars between the new Emperor's sons and the rebellious activities of the powerful nobles soon endangered the stability of the régime. Upon Louis's death his sons split the imperial heritage into three parts, Louis the German, 843-876, securing the East Frankish Kingdom. The area of this German kingdom was increased by the Treaty of Mersen, 870, under the terms of which Lotharingia was divided between the East and West Frankish Kingdoms. Threatened with dissolution during the weak reign of Charles the Fat, 876-887, the German kingdom was temporarily strengthened under Arnulf of Carinthia, 887-899. But during the rules of Louis the Child, 899-911, CONRAD I, 911-918, and HENRY I, the Fowler, 919-936, disintegration loomed seriously. These sovereigns strove to maintain the unity of the kingdom, but they were too weak to enforce their will upon the factious nobles. The confusion was increased by the circumstance that the kingship was elective and that the noble electors sold their votes for bribes and concessions. At this time, too, the Northmen and Magyars were making inroads upon German lands.

Quarrels with Papacy. OTTO THE GREAT, 936-973, however, vigorously reaffirmed the rights of the sovereign. He revived the title of Holy Roman Emperor which had been permitted to lapse. He conquered Italy and reestablished the fatal tradition that the emperors must exercise control both north and south of the Alps. The fulfillment of this ambition made it necessary for the emperors constantly to travel back and forth across the mountains, putting down revolts, now in Germany, now in Italy. And it led to disastrous quarrels with the papacy. Otto managed to establish his supremacy even over the popes, making them swear loyalty to him, and actually deposing John XII. (*See* JOHN.) In 955 he also decisively defeated the Magyars on the Lechfeld near Augsburg. Otto II (*see* OTTO), 973-983, and Otto III (*see* OTTO), 983-1002, proved themselves worthy successors of Otto the Great. In their relations with the papacy they took the attitude that the Holy Father was merely another bishop, albeit the important Bishop of Rome.

Under the next two rulers, Henry II (*see* HENRY I-VII), the Saint, 1002-24, and CONRAD II, 1024-39, the empire reached the high point of its medieval glory. These emperors fought and subdued Bohemians, Poles, Magyars and Burgundians, and gained the respect and awe of nobles and popes. Henry III (*see* HENRY I-VII), 1039-56, made and unmade popes at will. Oddly enough, he selected for this office some men whose attitude toward the relative powers of Church and State was at radical variance with his own. When, therefore, Henry III (*see* HENRY I-VII) was succeeded by his six-year-old son, HENRY IV, 1056-1106, the papacy, guided by the astute Archdeacon Hildebrand, later Pope Gregory VII (*see* GREGORY I-XVI), strove to assert itself. In 1059 Pope Nicholas II (*see* NICHOLAS I-V) took the power of electing the pope out of the hands of the emperors

and the people of Rome, and placed it in those of an appointed college of cardinals. The tradition also became established that the German rulers were to be known merely as kings until crowned by the pope. Thereafter they might assume the title of emperor.

During the course of these centuries FEUDALISM had had ample opportunity to develop, the system of vassalage had been perfected, and the principle of heredity in the assignment of fiefs had begun to prevail. The German bishops also generally were invested with their rights and powers by the king or emperor from whom they received the fief. In 1075, however, Gregory VII, feeling keenly the evils of lay investiture of bishops, launched a reform program, one element of which insisted upon papal investiture. To this Henry IV objected. Thereupon the princes, under the guise of religious fervor, took the opportunity to demand an extension of powers from the Emperor. Henry soon found himself fighting the papacy, the princes, and France, and ended by submitting to the pope at Canossa in 1077. But Gregory's triumph was of short duration. Henry soon renewed the quarrel, defeated his most recalcitrant subjects, and practically drove the pope into exile. Henry's tragic life came to a bitter end in 1106 with his death in battle against his rebellious son and heir, Henry V (*see* HENRY I-VII), 1106-25. The struggle between pope and emperor over investiture continued until settled by a compromise known as the CONCORDAT OF WORMS (1122).

With the reign of LOTHAIR THE SAXON, 1125-37, another difficulty entered into German imperial relations. Lothair was related to the Welf or Guelf family of Bavaria, whose pretensions to the throne later helped make life miserable for the Hohenstaufen emperors, in particular for Conrad III (*see* CONRAD I-IV), 1138-52, and FREDERICK I, Barbarossa, 1152-90. The latter eventually effected a truce with the Welf leader, HENRY THE LION, and then effectively built up his imperial possessions. Frederick was fond of interfering in Italian affairs. He aided the pope to put down the revolt of Arnold of Brescia, and he had himself crowned at Rome in 1155. His friendliness to the papacy gradually came to be interpreted as subservency, and in 1157 the pope referred to Germany as a papal *beneficium*. This precipitated another struggle regarding the relative powers of pope and emperor, and for 17 years Frederick had to fight the popes, the North Italian cities, and the Welfs who, still under Henry the Lion, had rebelled again. At Legnano, in 1176, Frederick suffered defeat at the hands of the Lombard League. In 1190 he was drowned while on a crusade to the Holy Land. His son Henry VI (*see* HENRY I-VII), 1190-97, by marrying Constance of Sicily, once more made it necessary for the emperor to divide his attention between Italy and Germany.

Upon Henry's death there was a double election, with resulting civil war between the followers of PHILIP OF SWABIA, 1198-1208, and Otto IV (*see* OTTO I-IV), 1198-1215. In the last year of his reign Otto

also had to fight against FREDERICK II, 1215-50, ward of Pope Innocent III. Frederick spent considerable time and energy fighting the Church, France, the Italian cities and his German subjects. Nevertheless, he governed Sicily exceedingly well.

Accession of the Habsburgs. Upon the death of Frederick's successor, Conrad IV (*see* CONRAD I-IV), 1250-54, there was a 19-year Interregnum, during which William of Holland (d. 1256), Alphonso X of Castille, 1257-62, and Richard of Cornwall, 1257-72, each of whom had slight claims to the crown, appeared as pretenders. Parallel conditions obtained in Italy where Charles of Anjou conquered Sicily and annoyed the popes. Accordingly the papacy supported the move of some German princes to elect a stronger emperor after the death of Richard. The throne thus went to RUDOLPH OF HABSBURG in 1273. Meanwhile there had grown up in Germany many prosperous towns inhabited by a middle class capable of resisting the greedy princes and interested in the preservation of law and order for the sake of trade and commerce. There also had appeared the class of knights, generally men with little landed property but with the right to bear arms. Between the 10th and 13th centuries, moreover, the Germans had extended their settlements southward and eastward in the direction of Austria and the Oder.

Rudolph, 1273-91, whose ancestral castle was in Switzerland, had a reputation for strength of character and uprightness. Nevertheless, the princely electors did not believe him capable of interfering seriously with their assumed prerogatives. His first great quarrel was with Ottocar II of Bohemia who had annexed the Austrian lands upon the death without issue of the last of the Babenbergers. Rudolph maintained that these lands automatically reverted to the empire and fought two campaigns against Ottocar, in 1276 and 1278. In the second of these campaigns the Bohemian ruler was killed and Rudolph assigned Austria, Styria, Carinthia and Carniola to two of his sons. Such exploits frightened the electors who now refused to name Rudolph's son Albert as their next ruler, but chose instead ADOLPH OF NASSAU, 1291-98. When, however, Adolph attempted to assert his imperial rights, the electors relented, deposed him, and raised Albert to his place. Albert, 1298-1308, in turn encountered difficulties when he tried to put into practice the emperor's theoretical powers. But he at least received aid from the towns which appreciated his desire to bring order and prosperity to the empire and more especially to his personal domains. He was assassinated in 1308 and succeeded by Henry VII (*see* HENRY I-VII), of Luxemburg, 1308-13, who attempted to restore the imperial power in Italy and reaffirm the emperor's supremacy over the popes, both of which ambitions had wisely been neglected by the Habsburgs.

The Empire and States Rights. Following Henry's death there was a double election and civil war in Germany, with a resulting further decline in the imperial prestige. Louis IV, the Bavarian, 1314-47,

and Frederick (III) of Austria, 1314-30, fought bitterly, each intent upon using the imperial power to strengthen his family possessions, for in these possessions at least, it was possible to rule without undue interference by the popes. It was characteristic of the time that many of the rulers who took a firm stand against Church interference in their private lands, allowed the popes to have great influence in imperial matters lest the nobles indulge in too many "religious" rebellions. Nevertheless a number of events of the 14th and early 15th centuries did tend to weaken the power of the Church in Germany and elsewhere. The revived study of Roman Law, which exalted the state and the ruler; the increasing French influence over clerical matters through the Babylonian Captivity of the popes at Avignon; the unblushing attempts of several pontiffs to secure political control in Germany; and the GREAT SCHISM, 1378-1415, during which several co-popes spent their energies in excommunicating one another, all tended to decrease respect for the papacy. Yet Charles IV (*see* CHARLES I-V) of Luxemburg, 1347-78, for the privilege of being crowned at Rome, returned to the Church numerous concessions which his predecessors had withdrawn. In 1356, moreover, this far from heroic King also promulgated the Golden Bull which definitely listed the seven electors, enumerated their rights and privileges, and outlined an elaborate court ceremonial.

Upon his death Charles was succeeded by his dispirited son Wenceslaus, 1378-1400, who was deposed by the electors and succeeded by the timorous RUPERT of the Palatinate, 1400-10. Then SIGISMUND, another son of Charles IV, became Emperor, 1411-37. He greatly added to the family possessions whose nucleus was Bohemia, and made his peace with the Church by permitting the burning of JOHN HUSS at the Council of Constance in 1415. He was succeeded by his Habsburg son-in-law, Albert II, 1438-39, and from this date until the end of the empire in 1806 all emperors were Habsburgs save Charles VII of Bavaria, 1742-45, and Francis I of Lorraine, 1745-65. Albert was succeeded by FREDERICK III (IV), 1440-93, father of the more famous MAXIMILIAN I, 1493-1519. Maximilian, often called "the Last Knight," added Burgundy to the Habsburg domains by marrying Mary, daughter of Charles the Bold. He also arranged the marriage between his son Philip and Joanna, daughter of Ferdinand and Isabella of Spain. The child of this union eventually came to be Charles V (*see* CHARLES I-V), 1519-56, ruler of Germany, the Netherlands, Spain, part of Italy, and Spain's overseas empire.

The 15th century witnessed a number of important developments in German life. The burning of Huss led to a series of bitter Hussite Wars lasting from 1420-33. The German migrations eastward necessitated prolonged conflicts with the Slavs, especially the Poles and Lithuanians. Several attempts, notably that of 1495 at the Diet of Worms, were made to reform the imperial administration and judiciary and

to strengthen the financial and military security of the empire. Unfortunately, the nobles were all more interested in their own little principalities, of which there were now over 300. In many of these principalities, moreover, it had become customary for the ruler to call together representatives of the various estates whenever he needed money or wished to raise taxes or give up territory. The increased use of firearms gave rise to a new class of professional soldiers, the *Landsknechte*, and simultaneously decreased the importance of the knights, some of whom now became robber barons, while others settled on small estates as country squires.

The Protestant Revolt. The cities had further developed and come under the control of sundry guilds. In some cases, for better protection, the towns had banded together into associations such as the Hanseatic League. Printing by movable type was invented, and Humanism had its start. Moreover, the movement known as the Protestant Revolt was well under way before Maximilian's death in 1519. Abuses connected with the Church had become glaring, particularly as there had been no serious attempt at reform after the Council of Basel, 1431-33. Moreover, there were even more important nationalistic, political, economic, social and intellectual reasons why a break with the traditional system in Germany now found many advocates. Princes, scholars, knights, peasants and devoutly religious people, all had valid motives for welcoming an overturn. MARTIN LUTHER merely struck fire to the mass of inflammable material already accumulated. And so the movement which at first had been regarded by the Catholic Emperor Charles V as a monks' squabble eventually made a large part of Northern Europe, including half of Germany, Protestant; brought on such bitter conflicts as the Knights' War of 1523 and the Peasants' Revolt of 1525; stimulated the Catholic Reformation, the founding of the Jesuit Order, and the extension of the Inquisition; and precipitated a series of so-called religious wars which lasted for 150 years, until the close of the disastrous THIRTY YEARS' WAR in 1648.

Charles was a sincere and able ruler but he faced staggering problems. He controlled lands in four continents. He had to win the imperial title against the competition of Henry VIII of England and Francis I of France. He attempted to introduce constitutional and administrative reforms into Germany and to reorganize that region as part of a large, centralized, but non-national empire. He was at war almost constantly, with the Poles, the Turks, the papacy, and especially France. These multifarious responsibilities together with his disappointment over his inability to check the spread of Protestantism so wore down the energies of Charles that he abdicated in 1556. His last great diplomatic achievement was the signing of the Peace of Augsburg, 1555, but even this was merely a truce since it made no provision for Protestant sects other than the Lutheran. Moreover, no agency was established to enforce the

treaty stipulation that all lands in Germany be restored as of 1552. Charles's son Philip received his Spanish, Italian and Dutch possessions, while the Austrian dominions and the imperial title went to his brother, Ferdinand I, 1556-64. Ferdinand, incidentally, had added Bohemia and Hungary to the Habsburg patrimony through marriage.

For a century after the accession of Ferdinand, conditions in Germany continued to grow worse. Religious animosities flared up anew and became aggravated when the Protestants quarreled amongst themselves. Lutheran Saxony, Catholic Bavaria, and the Calvinist Palatinate, were in the van of the quarrels, while the Habsburg emperors were further harassed by the Mohammedan Turks. Simultaneously, the increased use of the newly-discovered western trade routes and a series of unprofitable quarrels between the Hanseatic League and Elizabethan England brought about a decline in the prosperity of the German towns, particularly those of the Hansa. Ferdinand I, and then Maximilian II, 1564-76 (*see* MAXIMILIAN I-II), wisely tried to steer a middle course in the religious disputes, but Rudolph II, 1576-1612, reared by the Jesuits, actively supported Maximilian I of Bavaria in the furtherance of the Catholic Reformation. A Bavarian attack on the Protestant town of Donauwörth in 1607 resulted in the formation of two hostile, armed camps, the Protestant Union, 1608, and the Catholic League, 1609. When, therefore Matthias, 1612-19, sought to restore Catholicism to a preeminent position in Bohemia, the Bohemians broke into open revolt, 1618, thus precipitating the Thirty Years' War which raged on under Ferdinand II, 1619-37, and Ferdinand III, 1637-57.

The Danes under Christian IV, the Swedes under Gustavus Adolphus, and the French under Richelieu, all took an active hand in German affairs during the war, and despite the services of such able generals as Tilly and Wallenstein, the Catholic Emperor was constrained to sign the Peace of Westphalia in 1648, "the sorry end of a sorry epoch." By this Peace France secured Alsace, Metz, Toul and Verdun; Sweden acquired part of Pomerania; and both received votes in the Diet of the Holy Roman Empire. Switzerland was recognized as independent of the empire. Each German state was given the right to make war or peace without consulting the emperor. Calvinists, fortunately, were recognized on a parity with Lutherans. The already shadowy power of the emperor was dissipated completely. Economically, the effects of the war were frightful. It is estimated that two-thirds of the population disappeared, while five-sixths of the villages had been destroyed. Intellectual life was stifled, education practically came to a standstill, and there was a general moral decline among the people. One ray of hope came from the fact that Brandenburg emerged as the strongest German state next to Austria. But it took Germany 150 years to recover from the war and the unfortunate terms of the peace treaties.

Conflict With France. After Westphalia, the

German states drifted ever farther apart in their relations. Only two more Diets were convened, one in 1654, the other in 1663. This latter, however, out of sheer inertia, remained in session down to the end of the empire in 1806. The Habsburgs, moreover, used whatever imperial powers remained to them to bolster their private accumulations. The defense of the imperial boundaries was left to the border provinces. Time and again the Bavarian and Rhenish rulers aided the French in wars against other parts of the empire, and in 1652 Lower Saxony formed an alliance with Sweden. After the death of Ferdinand III there was a 15-month interregnum during which three electors sought to make Louis XIV emperor. It was due largely to the influence of the Great Elector of Prussia that the Crown went to Leopold I, 1658-1705. Under Leopold and Joseph I, 1705-11, there was almost constant conflict between the empire and France, with the lesser German states fighting now on this side, now on the other. The final result, so far as Germany was concerned, of the four big wars between 1667 and 1713, the War of Devolution, Dutch War, War of the League or Augsburg, and WAR OF THE SPANISH SUCCESSION, was to give France more land in the Rhine region, and to secure recognition of the Hohenzollern electors of Brandenburg as kings in Prussia. Matters were further complicated by the Turkish siege of Vienna in 1683. After the signing of the Treaty of Karlowitz, 1699, however, the Ottoman peril was more or less permanently removed. Another foreign influence was brought to bear upon German affairs in 1714 when the ruler of Hanover fell heir to the throne of England upon the death of his cousin, Queen Anne.

Prussia's Rising Influence. The extravagant Emperor Charles VI, 1711-40, who had neither sons nor brothers, devoted most of his reign to negotiating for the general recognition of his daughter MARIA THERESA as his successor. Since it was contrary to custom for a woman to rule the Austrian lands, Charles promulgated the Pragmatic Sanction, 1720, which declared these domains indivisible and designated Maria Theresa as heiress. Assent to this arrangement was secured from the Empire, England, France, Russia, Holland, Poland, Spain and Sardinia in return for special and often unnecessarily large territorial or commercial concessions. When Charles died, therefore, "he left his daughter a disorganized state, a bankrupt treasury, and a small ill-disciplined army, but he bequeathed her an ample number of parchment guarantees." It was now due largely to the abilities and popularity of Maria Theresa, 1740-80, that the Habsburgs retained any appreciable influence in German affairs. For by this time Brandenburg-Prussia, under the able leadership of the Great Elector FREDERICK WILLIAM, 1640-88, King FREDERICK WILLIAM I, 1713-40, and King FREDERICK II, the Great, 1740-86, had achieved great military strength. Frederick the Great, in fact, twice defeated the Austrians, in the WAR OF THE AUSTRIAN SUCCESSION,

1740-48, and in the SEVEN YEARS' WAR, 1756-63. As a result Austria was made to surrender her richest German province, Silesia. The gains made by the first partition of Poland in 1772 could hardly console Austria for this loss nor reconcile her to Prussia's rising influence in German affairs. A further temporary threat to Habsburg power appeared when the Bavarian and Saxon dynasties revived their claims to the imperial throne. Indeed, from 1742-45, Charles VII of Bavaria actually wore the crown. But then Maria Theresa's husband, Francis I, of Lorraine, was elected emperor, 1745-65. He in turn was succeeded by his son, JOSEPH II, 1765-90, and thereafter the Habsburg-Lorrainers controlled the throne until the dissolution of the empire in 1806.

Maria Theresa and her able minister Count Kaunitz labored incessantly to improve economic, social, military and administrative conditions in the Austria-Hungarian domains. Her son, Joseph II, strove equally hard to continue his mother's policies and to recapture for Austria a position of preeminence in Germany. But he was rash and impatient, and he failed to heed the power of traditions and of national inertia. The people did not take kindly to his hasty and peremptory, though often quite progressive, reforms. In the War of the Bavarian Succession, 1779, he also essayed to add Bavaria to the Habsburg possessions, at least in exchange for the distant Austrian Netherlands; but Prussia and Saxony frustrated this scheme. Joseph's attempts to lessen the influence of the Church, to uplift the lower classes, to introduce administrative uniformity, to foster German nationalism, and to push territorial expansion eastward and southward, all failed of genuine success. He died, disappointed and weary. Culturally, the Germans during the 17th and much of the 18th centuries had studiously aped the French. Throughout the empire there had been set up miniature models of Versailles, often ludicrous in their shortcomings and financially ruinous to the principalities concerned. The French tongue, French music, dress, customs, morals and philosophy were all the fashion, and things German were sneered at as being vulgar and common. It required the hardships and glories of the revolutionary wars to bring about a serious German nationalist reaction against things French and to recall to the Germans the cultural possibilities of their own language and institutions.

German imperial policy toward the turbulent events of the FRENCH REVOLUTION was left for Leopold II, 1790-92, and Francis I, 1792-1806, to decide. In Prussia, the ruler from 1786-97 was FREDERICK WILLIAM II, and from 1797-1840, FREDERICK WILLIAM III. The weakness of the imperial bonds was often in evidence during the revolutionary period. Austria and Prussia mistrusted one another, while many of the smaller states exhibited an unreasoning pro-French spirit. The second and third partitions of Poland, 1793 and 1795, roused new jealousies and intrigues. On no occasion did the French generals have to face a really united, patriotic Germany. Gen-

erally, some parts of the empire gloated over defeats administered to the other parts. Coalitions were unmade almost as quickly as they were made, and the logical result was the creation of the French protected Confederation of the Rhine and dissolution of the Holy Roman Empire, which, in the words of Voltaire, had been neither holy, nor Roman, nor an empire. On Aug. 6, Francis abdicated as Holy Roman Emperor. In anticipation of such a contingency he already had taken the title, 1804, of Hereditary Emperor of Austria.

Germanic Confederation. In the long run this termination of the phantom empire doubtless was of salutary effect. So also were the stimuli to German nationalism provided by the activities of Napoleon and the French invaders. At the CONGRESS OF VIENNA, 1814-15, France was made to restore most of what she had conquered. Austria released her Netherlandish possessions in return for large acquisitions in northern Italy. The number of German states was reduced to thirty-eight. The political organization of this group of states was provided for in the Act of Confederation of June 8, 1815, which established a loosely organized Germanic Confederation with a Diet presided over by Austria. Members of the federation were permitted to make treaties with foreign powers, provided these treaties were not aimed at the confederation or any of its members. There was no common army, flag, currency or tariff system.

From 1815-30 reaction, as interpreted and applied by the Austrian Minister Count Metternich, reigned supreme in the Confederation. Only a few of the states had written constitutions, and Prussia was quite content to follow Austria's lead. Such incidents as the Wartburg Festival, 1817, and the killing by a German student of the reactionary Russian agent Kotzebue, 1819, led the Diet to issue the Carlsbad Decrees, 1819, for the suppression of student societies, the supervision of the teaching by university professors, the muzzling of the press, and the investigation and suppression of so-called revolutionary plots. The desire for Liberalism and unification, inspired by the slogans of the French Revolution and the War of Liberation, however, could only be driven under cover, not abolished. This was evident in the numerous repercussions in the Germanies of the French Revolution of 1830. Though Austria and Prussia remained quiet, the rulers of such states as Brunswick and Saxony were forced to grant constitutions or to lighten the press and gag laws. This advance toward Liberalism was paralleled by a step in the direction of economic unification. In 1818 a uniform tariff had been established for all parts of the Prussian Kingdom. Ten years later three customs unions were formed: one between Prussia and Hesse-Darmstadt, another between Bavaria and Württemberg, and a third between several of the smaller states. For a time a bitter tariff war raged between these groups. Gradually, however, they were brought together under Prussian leadership in a *Zollverein*, or Customs

Unions, completed in Jan. 1834. The union included 23 states within whose territory freedom of trade was thus secured, and an economic basis created for the uniform development of the contemporarily-introduced railroads. By remaining aloof from the *Zollverein* Austria lost all opportunity to integrate her economic development with that of the other states.

When Frederick William IV, 1840-61, became king of Prussia, a new era of Liberalism appeared to dawn. A recent quarrel with the Catholic Church was patched up; the Brothers Grimm and other exiled German writers and scholars were invited to Berlin; the laws against civil liberties were made less severe; and there were rumors that a constitution might be granted and the bonds of the Confederation drawn tighter. Closer union, however, was rendered most unlikely by the conflicting economic theories of the members of the federation. The northern and eastern areas believed in free trade, while the southern and western regions stood for protection. Economic conditions in general were bad. The Silesian weavers, in particular, faced grave difficulties. Prices soared in 1845-46, and there was much emigration to other countries, especially the United States. Beginning with 1846 the unrest crystallized in minor revolts in a number of the states.

Into this atmosphere the news of the French February Revolution of 1848 struck like a bolt from the clouds. Throughout the Germanies demands were made for the abolition of the remaining feudal vestiges, for more religious toleration, for ministerial responsibility, and for freedom of the press. In the smaller states most of these demands were heeded. In Austria Liberalism had been growing despite the repression of the Metternich system. A flood of petitions poured in upon Ferdinand I, 1835-48. The news of the revolution in Paris led to insurrection in Vienna, and Metternich was forced to flee, the Emperor promising to grant a constitution. Freedom of the press was granted, a national guard was organized, and representatives of the people were called together. In Prussia there was street fighting between citizens and soldiers, and the King promised in future to convene the *Landtag* regularly. On Mar. 31, a *Vorparlament*, or preliminary Parliament, supposed to represent all German states, met at Frankfort and influenced the Diet to call a constitutional convention. Such a convention, the Frankfort Assembly, met in May, and contained one delegate for every 50,000 inhabitants of the Confederation.

The Assembly, controlled by Liberals, proceeded to the framing of a constitution, but came to grief over the question of the membership of the new confederation. An empire was proposed, with ministerial responsibility to a democratic assembly. But the representatives hesitated to admit into membership the non-German subjects of Austria and Prussia. Matters were further complicated by the plight of the Germans in the duchies of Schleswig, Holstein and Lauenburg. These duchies, though members of the Confederation, were governed by the King of

Denmark who strove to curtail many of the inhabitants' ancient rights. While the Assembly vacillated, provisional republican Governments were set up in the Rhenish Palatinate, Saxony, and elsewhere, while in Austria Ferdinand, after fleeing to Innsbruck, abdicated in favor of his nephew FRANCIS JOSEPH I, 1848-1916. The Assembly, influenced by a strong national spirit, finally decided against the admission of non-Germans into the new empire and offered the title of Hereditary German Emperor to Frederick William. The latter, however, refused to take a "crown of shame" from the hands of his inferiors. Besides, he knew that Austria and Russia would oppose his acceptance of a German imperial crown. The Assembly therefore broke up, and Austria and Prussia proceeded to devise rival plans for a new federation. In the end, 1851, the Confederation system established in 1815 was continued.

Meanwhile, in 1848 and 1850, the Prussian King had promulgated a conservative constitution providing for a bicameral legislature. Elections to the lower house were based upon an undemocratic three-class voting system in which the few wealthy citizens who together paid one-third the taxes were given equal representation with the larger middle group paying another third, and with the masses who together contributed the last third. In the Austrian domains, the Bohemians were first subdued, and then followed in rapid succession the suppression of the Lombards and Venetians, of the German Liberals in Vienna, and, in Aug. 1849, with the aid of Russian troops, of the Hungarians, who had already declared their independence and proclaimed a republic. Nationalism as well as Liberalism was crushed. In the Germanies, therefore, the net result of the revolutions of 1848 was to increase the number of constitutionally governed states, to give a renewed impetus to the movement for unification, and to demonstrate the inability of Austria to take a really German view of European affairs.

In the early 1850's Austria and Prussia became somewhat friendlier. The coups of Louis Napoleon in 1851 and 1852, and the developments leading to the CRIMEAN WAR, actually found the two leading German states cooperating diplomatically. In 1854 they reached a mild form of military entente. German interest in 1859 centered upon the Austro-Sardinian War in which Napoleon III played so important a part. The latter's diplomacy evoked memories among the Germans of the events of 1806-13, and there was a distinct feeling that the Confederation should come to Austria's support. Negotiations for aid soon were under way between Austria and Prussia; but these powers could not agree upon the question of leadership over the Confederation troops, and while Austria was being defeated, the rift between the two powers became greater than ever.

Prince William, who had become regent in 1858 because of the mental illness of Frederick William IV, became King of Prussia in 1861. Shortly before

this the Prussian Liberals had organized the Progressive Party which advocated ministerial responsibility, more local autonomy, and German unification. Between 1850 and 1860 the members of the *Zollverein* adopted a common currency, postal system and commercial code, and signed a series of commercial treaties with other states, culminating in 1862 with a reciprocity trade treaty with France. Austria, on the other hand, still clung to protectionism.

Bismarck. In 1862 the Prussian *Landtag* voted down an appropriation demanded by the Government for reorganizing the army in accordance with the plans of War Minister von Roon and Gen. von Moltke. In despair, William called upon OTTO VON BISMARCK to head the ministry and take charge of foreign affairs. Bismarck had no more success with the legislators, particularly after his offer to the Tsar to help put down the Polish Rebellion of 1863. For the next four years, accordingly, Bismarck ruled in defiance of the wishes of Parliament and without a budget. While Prussia was in this dilemma Austria attempted to strengthen her position in the Confederation by the creation of an Austrian controlled executive directory. But Prussia successfully opposed this step. With the succession of Christian IX to the throne of Denmark in 1863, the question of Schleswig-Holstein-Lauenburg once more awakened the sympathy of the German Nationalists. In violation of a London Agreement of 1852, which provided merely for a personal union between the duchies and Denmark, Christian, Nov. 1863, promulgated a single instrument of government for all his possessions. As a result the claims to the duchies of the German Duke Frederick of Augustenburg were revived. Neither Austria nor Prussia cared to appear lax in a matter of German patriotism, and so they asked Christian to rescind his proclamation. Upon the Danish King's failure to comply, Austria and Prussia declared war, 1864, and soon forced him to sign the Treaty of Vienna which assigned the duchies outright to the two victors.

Having come to the conclusion by this time that Austria opposed a strong, united Germany, Bismarck saw in the question of administering the duchies an opportunity to provoke a war with the Habsburg empire. The moment was opportune, for Austria was having difficulties with her Italian possessions and with Hungary, her budget was unbalanced, and her citizens were clamoring for reforms. As the first step in Bismarck's plan the two powers signed the Convention of Gastein, 1865, whereby, pending a permanent settlement, Austria agreed not to push the claims of the Duke of Augustenburg, Prussia secured Lauenburg outright for a money payment, and was to administer Schleswig, and Austria was to administer Holstein. Then Bismarck secured a promise of neutrality from Napoleon III at Biarritz, 1865, and negotiated an alliance with Italy, 1866. He was certain of the neutrality of England and Russia because of special commercial or diplomatic favors earlier rendered by Prussia to these powers. Finally,

Bismarck accused Austria of violating the terms of the Gastein Convention by continuing to further the cause of Duke Frederick. When Austria brought the matter before the Diet Bismarck warned that body that the matter concerned Prussia and Austria alone. When the Diet nevertheless proceeded to show interest in the case, Bismarck declared the convention void, drove the Austrian troops out of Holstein, and presented the Diet with a proposal for a new confederation without Austria. This the Diet rejected. Fearful of Prussia's growing power, the Confederation mobilized against King WILLIAM I and war resulted. Thanks to Prussia's military preparedness and Italy's assistance, slight though this was, the struggle became merely a SEVEN WEEKS' WAR, 1866. After the defeat at Königgrätz (or Sadowa), Austria signed the Peace of Prague, Aug. 3. Austria ceded Venetia to Italy and Holstein to Prussia. She also paid a slight indemnity and agreed to the dissolution of the Germanic Confederation, the extensive Prussian annexations at the expense of the smaller states, and the reorganization of northern Germany. The penalties were light because Bismarck wanted to win Austria's support for future action.

Hanover, of which the British had lost control in 1837, Hesse-Cassel, Nassau and Frankfort-on-the-Main were annexed by Prussia, which now comprised two-thirds of the land and people in the Germanies, exclusive of Austria. The remaining 21 states north of the Main were made to join a North German Confederation under Prussia's presidency, 1867-71. The Confederation was to be controlled by two houses, a *Bundesrat* containing representatives of the princes, and a *Reichstag* elected by universal manhood suffrage. The King of Prussia, as Confederation President, was to control foreign affairs and the army, and was given the power to declare a defensive war. The other four German states, Bavaria, Württemberg, Baden, and Hesse-Darmstadt were required to pay slight indemnities and were induced to sign alliance treaties with Prussia. Bismarck expected that fear of France and German Nationalism eventually would bring them completely into the new union.

With Austria divorced from German affairs, Bismarck sought to establish friendly contact with the Prussian Parliament and asked the *Landtag* for a bill of indemnity covering his actions. In the flush of victory this was gladly voted, for even the Liberals were conciliated by his insistence upon universal male suffrage for the Confederation *Reichstag*. Soon after the Austrian war many of the Progressives and the Prussian industrialists united to form a new National Liberal Party which favored a continuance of Bismarck's foreign policies, further governmental centralization, militarism, free-trade and complete unification.

Napoleon III now made successive bids for compensations in the Rhenish Palatinate, in Belgium, and in Luxemburg. In each case his ambitions were thwarted by Bismarck. At the same time the French

people were becoming highly excited over the prospect of getting a new, powerful eastern neighbor. From 1868 on, therefore, both sides prepared for war, physically and emotionally. Bismarck's diplomacy successfully isolated France. Russia still hated France for her part in the Crimean War. Italy was angry because Napoleon had withdrawn from the war of 1859, and was grateful to Bismarck for the acquisition of Venetia. Great Britain was annoyed when informed of Napoleon's designs upon Belgium. Austria still resented Napoleon's assistance to the Sardinians and was held in check by fear of Russia. The South German states, which in 1866 had signed offensive and defensive alliances with Prussia and in 1867 had entered into a customs union with the North German Confederation, were alarmed by Napoleon's Rhineland ambitions. It remained only to find a pretext for the clash. This presented itself in 1869 when the Spanish Liberals offered the throne of Spain to Prince Leopold of Hohenzollern-Sigmaringen, a Catholic relative of King William. Upon Bismarck's insistence, Leopold accepted the offer; but when Napoleon protested the prince withdrew his acceptance. There the case might have ended had not Napoleon sought to win a further diplomatic victory.

Upon instructions from Napoleon Ambassador Count Beneditti approached William at Ems and asked him to pledge himself never to permit the candidacy to be renewed and to explain that no offense to France had been intended. William refused the request and then refused a further interview. A report of the incident was dispatched to Bismarck, who at once edited it and released it for publication. In abbreviated form the dispatch appeared so brusque that the Germans believed their King to have been insulted, while the French believed their ambassador to have been affronted. As a result, on July 15, 1870, the French Chamber declared war. Prussia was ready, and to Bismarck's great satisfaction the South German states, regarding France as the aggressor, at once came to his support. The Germans won a surprisingly easy victory and at the Battle of Sedan, Sept. 1-2, Napoleon himself was captured. Paris surrendered in Jan. 1871; a preliminary peace was agreed upon at Versailles; and the final Frankfurt Treaty was signed on May 10, 1871. France ceded to Germany Alsace, except Belfort, and eastern Lorraine and agreed that a German army might occupy northern France until she should have paid an indemnity of five billion francs. Meanwhile, a series of agreements had been reached between Prussia and the South German states whereby the North German Confederation was converted into a German Empire, including all of the German states save Austria. The constitution of the North German Confederation was revised so as to meet the new conditions, and the imperial title was made hereditary in the Prussian ruling house. On Jan. 18, 1871, King William was proclaimed German Emperor. See GERMANY, *Government*.

German Empire. Bismarck, as chancellor, at once proceeded to consolidate the empire by far-reaching legal, financial, railway and military reforms. In these measures he was supported by the National Liberals and the Conservatives, Prussian agriculturists who benefited by the kingdom's preeminence in the empire. He was opposed by a few Progressives and by the Catholic Centrist Party. The Centrists aroused the ire of Bismarck by their advocacy of states' rights, their insistence that Germany aid the pope against Italy, and their apparent attempt to revive the old strife between popes and emperors by a ready acceptance of the recently enunciated doctrine of papal infallibility, 1870. The *Kulturkampf*, as the quarrel between Bismarck and the Catholics came to be known, raged from 1872-80, and involved the expulsion of the Jesuits from Germany, 1872, and the severance of relations between Prussia and the Holy See. Governmental repressive measures, including the Falk Laws which gave the state control over the education of clerics, and clerical pronouncements followed one another in rapid succession. In the end, Bismarck's activities made the Centrists appear as champions of religious freedom, and their *Reichstag* delegation was increased from 63 to 91 by the elections of 1874. Realizing the futility of further conflict, and fearful lest the growing Socialist movement prove to be more dangerous to his system than Catholicism, Bismarck by 1880 was ready to restore diplomatic relations with the papacy and gradually permitted the repeal of the anti-clerical laws. From 1874-1914 the Centrists continued to control about 100 seats in the *Reichstag*. They were a middle group and favored social legislation.

The fusion of several German Socialist groups into the Social Democratic Party, 1875, the economic dislocation resulting from the influx of the billion-dollar French indemnity within three years, and the attendant rise in cost of living, resulted in a radical poll of half a million votes in 1877. Two unsuccessful attempts by alleged Socialists on the life of William, 1878, were used as pretexts by Bismarck to secure the passage of anti-Socialist laws which remained in force, with renewals, until 1890. The war on Socialism was conducted in approved reactionary form, but included as one of its phases some excellent social legislation whose threefold purpose was to steal the thunder of the Socialists, to make the people contented, and to ensure healthy soldiers. Between 1881 and 1890, therefore, Germany was provided with national insurance systems and enlightened factory legislation. Nevertheless, the Socialist representation in the *Reichstag* grew from 12 in 1881 to 110 in 1912. Between 1879 and 1890, finally, Bismarck gave up his alliance with the National Liberals and, with the support of a bloc, substituted for his earlier policy of *laissez-faire* a neo-mercantilist program including the regulation of industry, protectionism (tariff of 1879), and imperialism. The rise of German industry and its need for markets and raw materials, combined with the propa-

ganda of the interested groups, convinced Bismarck of the necessity for colonies and in 1884-85 he induced the *Reichstag* to establish protectorates in Africa and Oceania.

The early foreign relations of the empire were promising. Both Francis Joseph and Tsar Alexander II were eager to show their attachment to William. In 1872 this trio of rulers formed the Three Emperors' League in order to advertise the cordiality of their relations. In 1873 Victor Emmanuel II visited Berlin, and William returned the courtesy at Milan. In 1874-75 it appeared as though Germany might declare a "preventive" war upon France before certain military increases authorized by the French Chamber could be put into effect; but Bismarck held the military party in check. By attempting, however, to maintain the balance of power between Russia and Austria-Hungary in the Balkans at the CONGRESS OF BERLIN, 1873, Bismarck incurred the displeasure of the Russians while strengthening the friendship of the Dual Monarchy. As a result, the Three Emperors' League lapsed and was replaced by a Dual Alliance between Germany and Austria-Hungary, 1879. In 1882 Italy, mainly through hatred of France, adhered to this combination, thus converting it into a TRIPLE ALLIANCE. Rumania joined in 1883. In 1881, moreover, Bismarck had been able to revive the League, this time as a written agreement of mutual benevolent neutrality in case of attack by some fourth power. The arrangement was renewed in 1884 and expired in 1887, to be followed by a secret, three-year Russo-German Re-Insurance Treaty embodying similar guarantees.

In 1888 William died. He was succeeded by his son, FREDERICK III, "whose well-known attachment to Liberalism boded no good to Bismarck." But Frederick was sick with cancer of the throat and died after a reign of only 99 days. He in turn was succeeded by his 29-year-old son, WILLIAM II, 1888-1918. Within two years after William's accession, Bismarck was dismissed. Both these men were strong-willed and obstinate, and neither was ready to concede precedence to the other. William refused to countenance another renewal of the anti-Socialist laws as demanded by the chancellor, and Bismarck objected to the Emperor's desire that cabinet members have direct access to him. Besides, Bismarck was old, and his political and economic ideas were perhaps less in harmony with the newer trends in business than were those of William. Bismarck's methods for some time had been meeting with increased opposition and dissent. With Bismarck out of the way, the Emperor, enthusiastic, secure in the knowledge of his divine mission, and anxious to gain for Germany "a place in the sun," determined to be his own chancellor. With the possible exception of PRINCE BERNHARD VON BÜLOW, all the appointed chancellors were ready to await William's bidding. The chancellors down to 1918 were Caprivi, 1890-94; Hohenlohe, 1894-1900; Bülow, 1900-09; THEOBALD VON BETHMANN-HOLLWEG, 1909-17; Michaelis, 1917;

Hertling, 1917-18, and Prince Max of Baden, 1918.

Under William's paternal eye, Germany's industrial rise was phenomenal. The tariff of 1902 extended protection to agriculture. The population grew rapidly. By 1914 German foreign investments totaled \$6,000,000,000. Indeed, the unfriendly attitudes of England and France to Germany were motivated to a considerable extent by fear or jealousy of the empire's trade, colonial rivalry, and military superiority. Germany's membership in the class of world powers was definitely established with the leasing of Shantung, 1898, the purchase of a number of Pacific Islands from Spain, 1898, the acquisition of two Samoan Islands, 1899, intervention in the Boxer uprising, 1900, and the securing of the Bagdad Railway concession in 1903. A powerful navy was provided for by laws of 1898 and 1900, and in 1913 German sea power was second only to that of England. The German army, especially after the passage of the Army Bill of 1913, was the most powerful in the world. Despite these advances, however, there was much discontent. The Socialist vote continued to increase, emigration was heavy, the demand among intellectuals for democracy became importunate, and the suppressed nationalities, including Danes, Poles and Alsace-Lorrainers, complained.

Diplomatically, the outlook was less reassuring than during Bismarck's régime. At the very outset of his reign William refused to renew the Re-Insurance Treaty with Russia, thereby giving serious offense in St. Petersburg and opening the way for a Russian rapprochement with France. Further, despite Germany's sympathetic attitude toward Russia in the Japanese war, 1904-05, the friendship between the two countries waned when it became evident that William favored Austria in the Balkan rivalry. The attempt to retain England's friendship was negated by tactless speeches and interviews on the part of William, by the Kruger telegram, and by the increased competition offered the British by German merchants and the German navy. Even the Triple Alliance, which had been temporarily strengthened by Germany's influence in Turkey, was soon weakened by the opposing interests of Austria and Italy and by the Turco-Italian War, 1911-12. Franco-German relations several times verged upon armed conflict, particularly during the Moroccan crises of 1905 and 1911. Meanwhile France and Russia had formed an alliance; France, England and Russia had concluded an entente; and, as a result of the BALKAN WARS of 1912-13, the Balkan situation had shifted in favor of the Entente powers.

World War. By 1914, Europe was divided into two hostile, armed camps, each anxious to win diplomatic victories over the other, and each nervous lest it be caught unawares. Germany's situation in particular was unenviable, with France on one of her borders and Russia on the other; with the belief firmly implanted in the mind of many Germans that their land was purposely being "encircled" with "an iron ring" of hostile powers; with the evident luke-

warmness of Italy as an ally; and with the all too plain weakness of the one loyal ally, Austria-Hungary. Under the circumstances, it was only to be expected that the accumulated ill-will caused by exaggerated nationalism, irredentism, economic rivalries, imperialism, militarism, alliances, and the absence of proper machinery to settle international disputes peaceably should have resulted in the WORLD WAR.

Upon the declaration of war all political parties voted to support the Government. But as the struggle dragged on two groups of malcontents seceded from the Social Democratic Party; the Independent Socialists, led by Hugo Haase, who demanded immediate peace; and the Spartacists, led by Karl Liebknecht and Rosa Luxemburg, who desired the immediate, forceful establishment of a proletarian dictatorship. The bad harvests of 1916-17 and the example of the Russian Revolutions, 1917, added materially to the discontent arising from the failure to achieve a decisive military victory. Strikes occurred with alarming frequency, particularly in munition plants, and in Oct. 1918, the sailors at Kiel mutinied. The apparent failure of the submarine campaign, the entry of the United States into the war, the failure of Ludendorff's (*see* LUDENDORFF, ERICH) last drive in 1918, the general retreat of the German armies in France and President Wilson's refusal to treat with the Emperor's régime, led to the abdication of William on Nov. 9, 1918, and his flight to Holland. The spirit of revolt in the empire spread quickly. On Nov. 7 the Bavarian King had fled, and on Nov. 8 Bavaria had been declared an independent republic. In Berlin the returning soldiers and the workers organized councils, while a deputation of Social Democrats, led by FRIEDRICH EBERT and Philip Scheidemann, demanded that the chancellor surrender the government to the representatives of the people. Chancellor Prince Max agreed, Nov. 9, and thus, by an almost bloodless revolution, the empire was converted into a republic.

German Republic. A Provisional Government representing right and left wing Socialists, in the form of a Council of Six People's Commissars, was set up. The most difficult immediate task of the Commissars was to suppress the Spartacists on the one hand, and the imperial reactionaries on the other. Gustav Noske, a former strike organizer, assumed control of the police forces and, with some bloodshed, eventually established quiet. In Jan. 1919, all men and women over 19 were permitted to vote for representatives to a National Assembly to meet at Weimar in February. The desire for order was great and the moderate parties secured most of the seats. The Social Democrats had the most delegates. Accordingly, a coalition of Social Democrats, Centrists and Democrats was organized, and Ebert was designated President of the *Reich*.

Before drawing up a constitution for the republic, the Assembly had to put down local revolts and ratify the Peace Treaty. This document deprived Germany of one-eighth of her European land area; of 6,500,000

people; of all her colonies, foreign holdings and foreign investments; of most of her armaments and merchant marine, and of a large percentage of her material resources. It also made her sign a blank reparations check, and provided for an Allied army of occupation of the territory on the left bank of the Rhine. With these matters temporarily out of the way, the Assembly proceeded to give Germany one of the most democratic of modern constitutions. A republican federation was established, an Economic Council of the Commonwealth with powers to supervise the process of socialization was set up, and women were given absolute civil equality with men. Following the signing of the treaty and the adoption of the constitution there came a troublous period during which the nationalistic reactionaries assassinated many prominent Catholics, Jews and Socialists, including Walther Rathenau, a brilliant Bavarian political philosopher and industrial organizer. Simultaneously several attempts were made to overthrow the Government, 1921 and 1923.

The economic disorganization of the country; the difficulty of meeting the huge reparations payments; the Franco-Belgian occupation of the Ruhr, the industrial heart of Germany; the separatist movements in the Rhineland and Bavaria; and the reckless resort to the printing press combined to cause a precipitous decline in the value of the mark. In the fall of 1923 the mark was quoted in Cologne at four trillion to the dollar! Complete dissolution was checked in 1923 by a forced stabilization of the mark at its pre-war par value. A new, gold *Rentenmark*, later replaced by the *Reichsmark*, was issued and circulated with the paper marks at the ratio of one to one trillion. This procedure bankrupted many individuals and firms, but in the long run it helped to restore confidence, particularly when followed by the introduction of the Experts' or DAWES PLAN for Reparations, 1924, and the resultant loan to Germany of 800,000,000 gold marks, as well as the Franco-Belgian evacuation of the Ruhr.

In Feb. 1925 President Ebert died. Since the constitution made no provision for a vice-president, new elections had to be held. In April the 77-year-old Field-marshal PAUL VON HINDENBURG was elected for a seven-year term on a Nationalist ticket. His election caused consternation in foreign countries, particularly in France, and extremists, fearing that his victory was but a prelude to a Hohenzollern restoration, demanded that he be removed by force. But Hindenburg soon convinced the world that he would uphold his oath to the republican constitution. He remained aloof from all party connections and was guided in his decisions solely by a desire to restore Germany to a position of honor and respect.

The number of parties in Germany after the war varied between 10 and 15, with the Social Democrats forming the largest single group in the *Reichstag*. In the elections of 1930 the Social Democrats received 143 out of the 577 seats. The second largest contingent was the group of 107 National

Socialists or "Nazis." These, under the leadership of the Austrian ADOLPH HITLER, had seceded from the National People's Party. They stood for a nationalist dictatorship, anti-Semitism, repudiation of war guilt and reparations, and restoration of the lost territories, especially the colonies. The success of the Nazis made it hard for the Government to adopt a conciliatory foreign policy; but with the able support of Hindenburg, the several coalition cabinets of the Centrist leader HEINRICH BRUENING carried on with tolerable success throughout 1930-31.

Von Hindenburg was reelected president in April 1932, with over 19,000,000 votes, Hitler being his closest competitor, with over 13,000,000 votes. Hitler's prestige, however, increased and his party gained ground in the *Reichstag*. Franz von Papen succeeded Bruening as Chancellor on May 30, 1932.

Germany's post-war economic recovery was amazing. Despite her material losses and the compulsion to pay heavy reparations, the new republic soon recaptured a leading industrial position. Cartels were developed, rationalization was applied to all phases of industry, and great progress was made in the development of synthetic products. But the depression of 1930-31 caused great hardships and in the latter year the number of unemployed was well over 7,000,000. Diplomatically, German efforts between 1919 and 1925 were devoted to regaining a position in the family of nations. GUSTAV STRESEMANN, who was foreign minister from 1923-29, was an able and conciliatory diplomat whose crowning achievements were the signing of the LOCARNO PACTS, 1925, and the admission of Germany to the LEAGUE OF NATIONS, 1926. Friendly relations with England, Russia and Italy were maintained, and in 1931 a rapprochement with France appeared imminent. Late in 1929 the YOUNG PLAN, which reduced the total reparations bill to something over \$8,000,000,000, went into effect, and in Dec. 1930 the last foreign soldier left German soil. In 1931 there remained as outstanding German problems the question of union with the German republic of Austria, a desire to share in the control of the mandates, the wish that all countries disarm equally with the republic, Allied repudiation of the war guilt theory, and the necessity for further downward revision of reparations. W. C. L.

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GERMINATION in seeds, the sprouting of seeds for which process favorable conditions of moisture, oxygen (from air), and a suitable temperature must be supplied usually after an adequate rest period. With absorption of water, swelling occurs as evidenced

by increase in size. The stored food gradually becomes available for the embryo plant by digestion and transfer. The first evidence that the water and food are being used for enlargement of the embryo appears in the emergence of the root-tip which grows downward. It soon develops root-hairs which help both to anchor the seedling firmly and to absorb water from the soil. Next (or at the same time but more slowly) the stem starts growth and gradually assumes an upright position. Frequently it is the portion below the cotyledons, the hypocotyl, which elongates and withdraws the cotyledons from the seed coat, bringing them up into the light. Here they open and become green, serving as foliage leaves. Sometimes, as the epicotyl or stem above them elongates, the cotyledons remain in the seed coat. In either case, the plumule or young shoot expands and becomes green. Germination is complete when the seedling has become able to manufacture its own food from constituents of air and soil. N. E. P.

GÉRÔME, JEAN LÉON (1824-1904), French painter, was born at Vesoul, department of Haute-Saône, May 11, 1824. He studied under Paul Delaroche and made his reputation with an allegorical canvas representing the decline of paganism and the birth of Christianity. His best works are colorful canvases of eastern subjects. Gérôme also executed historical canvases and revived the art of polychromed sculpture. He had begun a series of *Conquerors* in silver, gold and precious stones when he died at Paris, Jan. 12, 1904.

GEROUSIA, the Spartan body of elders, consisting of the two kings and 28 others who were over 60 years of age, elected by vote of the people. They prepared matters for the general assembly to vote upon, had general criminal jurisdiction, including the right to inflict the death penalty, and could check both the kings and the assembly.

GERRY, ELBRIDGE (1744-1814), fifth Vice-President of the United States, was born at Marblehead, Mass., July 14, 1744. Graduating from Harvard College in 1762, he entered business, but in 1772 became a member of the Massachusetts General Court, and was active in pre-revolutionary resistance of Great Britain. He was a member of the Continental Congress, 1776-81, of Congress under the Articles of Confederation, 1783-85, and was a signer of the Declaration of Independence. Gerry was a conspicuous member of the Constitutional Convention at Philadelphia in 1787, which he offended by his inconsistencies and alleged contradictory opinions. He opposed the ratification of the Constitution upon his return to Massachusetts and although not a delegate to the ratifying convention, he was invited to attend in order to give information. He withdrew indignantly when he was accused of exceeding his guest privileges. Upon his promise to support the Constitution he was elected to the new Congress in 1789. The Republican party had no organized existence until after his re-election in 1790 and since he was not a Federalist, he was regarded as a non-party man.

In 1797, John Adams appointed him with John Marshall and Charles C. Pinckney as the mission to France which subsequently led to the XYZ affair. (See XYZ MISSION.) Gerry remained in France after the departure of his associates, for which he was severely criticized. Four times from 1800 to 1803 he was defeated as the Republican candidate for Governor of Massachusetts. He was elected, however, in 1810, and sponsored a bill so re-districting the State as to exclude the opposing party from effective legislative representation, and the name "gerrymander" has since been applied to this practice. In 1812 Gerry was elected Vice-President of the United States, and held office until his death, at Washington, D.C., Nov. 23, 1814.

GERRYMANDER, a term applied to manipulation of the shape of electoral districts (see ELECTORAL COLLEGE) in order to give one party more than its fair share of representatives. Since the only restriction is that the district be of contiguous territory, it is possible to concentrate most of the voters of one party in a few districts, leaving the others easily carried by the opposition. The name was coined to combine a conception of the shape of the salamander with the name of ELBRIDGE GERRY, innovator of the system.

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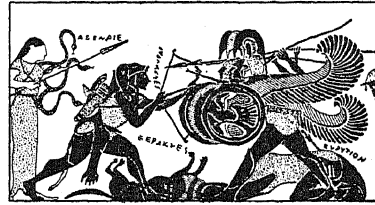
GERSHWIN, GEORGE (1898-), American music composer, was born at Brooklyn, N.Y., Sept. 26, 1898. After studying the piano with Haubitzer, and composition with Rubin Goldmark, Gershwin wrote several light operas, among them *La La Lucille* and *Show Girl*, the last produced in 1929. He has also composed "jazz" in serious musical form. The latter works include *Rhapsody in Blue*, a piano concerto in F., and *An American in Paris*, which had symphony production at New York in 1928.

GERSONIDES, LEVI (1288-1344) (Levi ben Gershon; known also as Ralbag, and Leon de Bagnols), famous French Jewish philosopher, physician, astronomer, exegete and mathematician, was born at Bagnols in 1288. Practically nothing is known of his life except that he lived successively in several cities of France, Orange, Perpignan and Avignon, probably earning his living through the practice of medicine. He wrote a commentary on the Bible and on the Talmud, as well as the *Milhamoth Adonai*, or *The Wars of the Lord*, a work on the philosophy of religion; also various exegetical and mathematical works. As an astronomer he invented an instrument by means of which more certain heavenly observations could be made. He died in 1344.

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GERYON, in Greek mythology, a monster with three heads, son of Chrysaor and Callirrhoe, was king of Erytheia. His droves of cattle were guarded by a two-headed dog, Orthrus, and a giant shepherd, Eurytion. One of the labors of HERCULES was to slay Geryon.

GESTA ROMANORUM ("Deeds of the Romans"), a collection of anecdotes and tales, moral in purpose, compiled late in the 13th century. This collection includes Oriental romances, miracle stories,



HERCULES AND THE THREE-HEADED
MONSTER GERYON

From a Greek amphora

beast fables and legends of the Virgin, most of which are short and told with an extreme simplicity, almost completely lacking in rhetorical ornament, all of them dressed in the external features of medieval life and manners. The *Gesta* have been a storehouse of materials for many authors, most notably for GEOFFREY CHAUCER, Gower and SHAKESPEARE.

GESSNER, SALOMON (1730-88), Swiss poet and landscape painter, was born in Zurich, Apr. 1, 1730. He had some success as a landscape painter but gave up painting for literature. He produced the *Idylls*, 1750-54, containing popular pastoral poems; *Daphne*, 1754, a popular romance; and the *Death of Abel*, 1758, a Biblical epic. He is called the Swiss Theocritus, and his world is one of love-sick shepherd and fickle shepherdesses. The popularity of his works illustrates the sentimental romanticism of his age. Gessner died in Zurich, Mar. 2, 1788.

GETHSEMANE, an estate located almost a mile from Jerusalem, of which the garden was the scene of Jesus' Agony, betrayal and arrest. The garden is about 150 ft. square and is surrounded by a wall. Within its confines are several ancient olive trees which many believe existed at the time of Jesus.

GETTYSBURG, a borough and the county seat of Adams Co., in southern Pennsylvania, situated on the Lincoln Highway, 35 mi. southwest of Harrisburg. It is served by an airport and two railroads. Gettysburg was the scene of the decisive battle of the Civil War, fought July 1, 2 and 3, 1863. (See GETTYSBURG, BATTLE OF.) The battlefield was made a National Park in 1895. A monument marks the place where Abraham Lincoln delivered his famous address at the dedication of the National Cemetery. The lines of battle formation have been marked, and observatories by which the whole field may be viewed, have been erected. In an old cottage on the grounds there is a museum. Gettysburg was founded by General James Gettys in 1780, and incorporated as a borough in 1806. It has furniture, fertilizers, shirt and silk factories; and is the seat of Gettysburg College and a Lutheran Theological Seminary. Pop. 1920, 4,439; 1930, 5,584.

GETTYSBURG, BATTLE OF, July 1-3, 1863, the most important battle of the CIVIL WAR. Gen. Lee,

heading 75,000 Confederate troops, was marching toward Harrisburg, Pa., when in consequence of intelligence that the Federal army, now under Gen. Meade, was in pursuit, he decided instead to concentrate his army at Gettysburg, about seven miles above the Maryland-Pennsylvania boundary, and attempt to annihilate the Army of the Potomac. Action began before the main body of the Federal army had arrived. On July 1 an advance detachment under Gen. Reynolds engaged a superior Confederate force under Gen. Ewell, and was repulsed with the death of its commander; Gen. Howard arrived opportunely to check the retreat. The Union army took position on Cemetery Ridge, south of Gettysburg; the enemy was aligned on Seminary Ridge, the western side of the valley. The battle on July 2 cost either side about 10,000 men; the Confederates gained a slight advantage by the capture of Culp's Hill, the northern end of Cemetery Ridge. Next morning the Federal artillery, directed against Culp's Hill, drove back the Confederates. Lee massed his artillery, more than 200 cannon, against the Union center, ineffectively. Then led by 15,000 men under Gen. Pickett, the entire Confederate army attempted a grand assault. Generals Meade and Hancock, commanding ably, checked the advance after a desperate musketry engagement; the shattered Confederate line retreated, escaping unmolested into Virginia. The Confederate loss was 3,903 killed, 18,735 wounded, 5,425 missing; the Federal casualties, including the missing, were about 5,000 less. The defeats of Gettysburg and Vicksburg (*see* VICKSBURG, SIEGE OF) were the turning point of the Civil War.

GETTYSBURG ADDRESS, LINCOLN'S. On Nov. 19, 1863, at the dedication of the Gettysburg field as a national cemetery, Abraham Lincoln delivered his Gettysburg Address, which, though short, is one of the world's great masterpieces. It is as follows:

"Fourscore and seven years ago our fathers brought forth on this continent a new nation, conceived in liberty and dedicated to the proposition that all men are created equal.

"Now we are engaged in a great civil war, testing whether that nation or any nation so conceived and so dedicated can long endure. We are met on a great battlefield of that war. We have come to dedicate a portion of that field, as a final resting-place of those who here gave their lives that that nation might live. It is altogether fitting and proper that we should do this.

"But, in a larger sense, we cannot dedicate—we cannot consecrate—we cannot hallow—this ground. The brave men, living and dead, who struggled here, have consecrated it, far above our poor power to add or detract. The world will little note, nor long remember, what we say here, but it can never forget what they did here. It is for us the living, rather, to be dedicated here to the unfinished work which they who fought here have thus far so nobly advanced. It is rather for us to be here dedicated to the great task remaining before us—that from these honored dead

we take increased devotion to that cause for which they gave the last full measure of devotion—that we here highly resolve that these dead shall not have died in vain—that this nation, under God, shall have a new birth of freedom—and that government of the people, by the people, for the people shall not perish from the earth."

GEVAËRT, FRANÇOIS AUGUSTE (1828-1908), Belgian musicographer and composer, was born at Huyse, July 31, 1828. He composed several operas, few of which are now remembered. In 1871 he succeeded Fétis as director of the Brussels Conservatory, and in 1873 was elected a member of the French Academy of Fine Arts. His outstanding contribution was in the field of musical theory and history, represented by such works as *Traité d'Instrumentation* 1863, *Histoire et Théorie de la musique de L'Antiquité* 1875 and *La mélopée antique* 1895. He died at Brussels, Dec. 24, 1908.

GEYSER, a hot spring subject to intermittent fountainlike eruptions of water and steam. Geyser action is explained by the gathering of steam in deeper parts of the narrow and often tortuous geyser-tube, in which groundwater becomes superheated by contact with uncooled volcanic rock. When pressure reaches the explosion point, sudden expansion flings the overlying column of water skyward with a roar.

These spectacular spouting springs are confined to a few regions of dying volcanic activity, notably Iceland, New Zealand, and especially the Yellowstone National Park, Wyoming, which possesses the finest geyser-basin in the world. The 100 geysers in the Park vary greatly in size, frequency of activity, and the regularity and duration of eruptions. The most famous, "Old Faithful," blows off at intervals of an hour, throwing a slender jet over 100 ft. into the air for five to six minutes at a time. Some 3,000 bbls. of hot water are thrown out at each eruption. The still finer "Giant Geyser," is active at intervals of one to two weeks, when it spouts for an hour, the water reaching a height of 250 ft. Eruption may be induced by dropping stones into some geyser.

The beauty of these "water-volcanoes" is enhanced by the singular cones of mineral matter, called sinter, or geyserite, built up around the vent. These are often highly colored, partly by minute plants flourishing in the heated water. During quiet intervals, these craters contain pools of vivid blue or green mineral-laden water.

GHAZI, a Moslem term for one who undertakes a *ghazwa*, a military campaign, or plundering expedition. It is applied, also, honorifically to one who has distinguished himself in war, especially against unbelievers. President Mustafa Kemal, of Turkey, became *ghazi* in the Turkish wars. By tradition, it is highly meritorious for Moslems to enroll as *ghuza* (plural of *ghazi*) on the path of Allah in holy war. (*See* JIHAD.) Mohammed declared Paradise to be "under the shadow of the sword."

GHENT, the capital of the province of East Flanders, in Belgium, is an important industrial cen-

ter and port. Situated on the Scheldt River at its juncture with its main tributary, the Lys, Ghent is served by navigable canals connecting it with the sea. It is the center of the cotton and linen industries of Belgium, and carries on an extensive trade with the neighboring towns. Among its varied industries the tanneries and sugar refineries are the most important. It is famous for its flowers and flower shows. A very old city, seat of the counts of Flanders, Ghent had a stirring medieval history politically, and, in the rise of the guilds, economically. The weavers' guild of Ghent was particularly important. Ghent is a picturesque town, with many interesting old buildings. It was occupied by the Germans, 1914-18. Est. pop. 1930, 169,322; with suburbs, 217,039.

GHENT, PACIFICATION OF, a temporary union of the 17 provinces of the Netherlands consummated in Nov. 1576. All had common political grievances but differed sectionally in race and religion. The central provinces, Flanders and Brabant, were Flemish and largely Catholic; the southern, Walloon and Catholic; while the northern, which began the revolt, were Dutch and Calvinist. Indignation at the outrages committed by the Spanish soldiery after the death in 1576 of the governor general Requesens led, however, to an agreement being reached that brought the entire group together until Alexander Farnese, duke of Parma, broke up, 1579, this short-lived unity through his skillful appeal to Catholic solidarity.

GHENT, TREATY OF, Dec. 24, 1814, a treaty between the United States and Great Britain, closing the WAR OF 1812. The peace commission appointed by President Madison, which included Albert Gallatin, John Quincy Adams, Henry Clay, Jonathan Russell and James A. Bayard, met with the British negotiators at Ghent, Belgium, and after long discussions which revealed the unwillingness of either party to make important concessions, agreed upon these provisions: the cessation of hostilities, mutual release of prisoners and restoration of all conquered territory, and the appointment of a commission to settle the American-Canadian boundary dispute. (See RUSH-BAGOT CONVENTION.) The vital differences which had led to the war, impressment of American seamen, the right of search, the navigation of the Mississippi, the control of the Great Lakes, the right of Americans to fish in Newfoundland and Labrador waters, the rights of neutrals and the attitude of international law toward blockades, were ignored. Since both belligerents primarily desired a cessation of hostilities, the treaty was universally welcomed.

GHETTO. Originally the word ghetto designated the segregated street or city quarter in which the Jews were compelled, through the intolerance of their non-Jewish neighbors, to dwell in various cities for many years. The ghetto section of the city was enclosed by gates which were locked every evening and reopened every morning. During the Middle Ages the Jews were forbidden to leave the ghetto after sunset on any day, including Sundays and the Christian

holidays. Such early Jewish ghettos, or Jewish streets, existed as early as 1090 in Venice and Salerno, Italy, and at Prague in the 10th century. However, the ghetto as the place where Jews lived together in a definitely determined part of the town was known even to antiquity. Thus classical Rome had a Jewish quarter in the Trastevere; there was such a Jewish quarter in Alexandria, Egypt, as well. The term ghetto is probably derived from the Italian word *gietto*, the cannon foundry at Venice near which the first Jewish quarter was located in 1516. In subsequent times ghettos were established in the various cities of Austria, Bohemia, Germany, Hungary, Italy, Moravia, Poland and Turkey. The most important ghettos were those at Frankfort-on-Main, Nikolsburg, Prague, Rome, Trieste and Venice.

Spain, too, had its ghettos, for especially in the 13th and 14th centuries the Jews in all the Spanish cities dwelt in a separate quarter called the *Juderia*. In Barcelona, in the 14th century, all Jews were forbidden to live outside of the Jewish quarter, and no Christian was permitted to rent a house to Jews. In 1480, by decree of Ferdinand and Isabella, which applied to the whole of Spain, the ghetto of Madrid as well as the Moorish quarter of the town was surrounded by a wall. In Portugal the Jews lived in separate Jewish quarters called *Judarias*, which were closed up every evening as soon as the bells rang for evening prayers; these quarters were guarded by two royal watchmen, and after the sounds of the evening Ave were heard, no Jew, under severe penalty, was permitted to show himself outside of the Jewish quarter.

The ghetto usually consisted of only a few narrow streets. Within a few years after their establishment they usually became terribly overcrowded, since little or no room was allowed for their expansion and new Jewish inhabitants of the cities were compelled to reside there. As a result they became filthy, unhealthy, breeding-places for disease, and fire-traps. Thus on Jan. 4, 1711, a great conflagration destroyed the entire ghetto of Frankfort-on-Main. Probably the only good feature of the ghetto was that it generally served to protect the Jews from hostile attacks; nevertheless, such attacks were often made on them, and they were often expelled from their ghettos, as in 1670 from Vienna, and from Prague in 1744-45. The ghetto further developed a close community of spirit among the Jews confined within it, thus strengthening the bonds of their religious life. However, it greatly narrowed the horizon of the Jews socially, educationally and culturally, in a highly artificial manner, and thus for hundreds of years prevented them from becoming an integral part of the civic, economic and social life of the countries in which they were so confined. The ghetto therefore constituted a form of unnatural restraint, and tended to make the Jews suspicious of all non-Jewish persons and ideas, wrapped up solely in their own people and in their own affairs.

The year 1789 marked the beginning of the death-

knell of the ghetto. The French Revolution, with its principles of freedom and equality for all people, and the general Revolution of 1848 throughout Europe led to its utter abolition. To-day no ghetto, in the medieval sense, exists in the entire world, although the term ghetto is now usually applied to that part of a city which is mainly inhabited by Jews.

A. SH.

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GHIBELLINES. See GUELPHS AND Ghibellines.

GHIBERTI, LORENZO (1378-1455), Italian sculptor, was born in Florence and learned the goldsmith's trade from his father. In 1402 the Merchants Guild of Florence held a competition for a pair of bronze doors for the Baptistery. The trial panels of Ghiberti and Brunelleschi, now in the Bargello, were judged equally fine; but as the latter withdrew from the contest, Ghiberti received the commission. The next 20 years were occupied with the completion of 28 panels, with scenes from the life of Christ, which in shape conform with the doors of the south side of the Baptistery, executed by Andrea Pisano in 1330. Upon their completion Ghiberti received a commission for a second pair of doors, for the east entrance to the Baptistery. In these he freed himself from the Gothic framework of Pisano and executed 10 large panels, with scenes from the Old Testament. Although Michelangelo praised them highly, these east doors, which are more like paintings in bronze than sculpture, are less plastically effective than the first pair. Ghiberti died at Florence, Dec. 1, 1455.

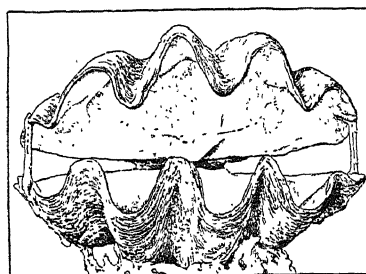
GHIRLANDAJO, DOMENICO (1449-94) Florentine fresco painter whose real name was Domenico Di Tommaso Curradi Di Doffo Bigordi, was born at Florence in 1449. He was the son of a garland-maker, from whom he received the nickname by which he is known. Ghirlandajo executed a fresco of *St. Peter and St. Andrew* in the Sistine Chapel, Rome and a series from the life of St. Fina at San Gimignano. His important Florentine works are the frescoes in the church of the Ognissanti, the Sassetti Chapel in the Church of Santa Trinita and the choir in the church of Santa Maria Novella. In the latter the painter has introduced the portraits of prominent contemporaries. Ghirlandajo died at Florence, Jan. 11, 1494.

GHIRLANDAJO, RIDOLFO (1483-1561), Florentine painter, the son of Domenico Ghirlandajo, was born at Florence, Jan. 4, 1483. He studied the cartoons of Leonardi da Vinci and Michelangelo, and soon rose to the head of his profession. Like his father he executed all kinds of commissions and, for example, helped to paint the huge scenic canvases for the wedding of Giuliano de Medici and the entry of Leo X into Florence. His best works, such as the *St. Zenobius Resuscitating a Child*, 1517, in the Uffizi, Florence, are expressive and skilful, but after 1527 he began to grow repetitious and mannered. Ghirlandajo died at Florence, Jan. 6, 1561.

GHOST, the appearance of the form or specter of a deceased person. It is a popular term referring to one form of APPARITION. Ghosts, wraiths or doubles go back to primitive belief in spirit power and a future life; in that sense every object had its ghost or spirit double. Ghosts were believed to appear to give warning or to haunt (see HAUNTINGS) the scenes where in life they have been mistreated, the ghost of a murdered man giving the murderer no peace. Ghosts making mysterious sounds and general noisy disturbance, wrecking furniture and destroying property, bore the German name of POLTERGEISTS. Hallowe'en pranks are connected with this tradition.

GIAMBATTISTA. See DONATI, GIOVANNI BATTISTA.

GIANT CLAM, the popular name for a species (*Tridacna gigas*) of bivalve mollusk which lives in shallow water on the coral reefs of the East Indies. The giant clam is the largest of all mollusks. Its shell may be over three feet long and weigh more than 400 pounds, while the animal itself sometimes reaches a weight of 20 pounds. The creature is, of course,



GIANT CLAM OR BEAR PAW
From the Philippine Islands

sedentary, and is frequently found deeply sunk in the coral. The two halves or valves of the giant clam's shell have interlocking scalloped margins, and are deeply ribbed on the outside; inside they are smooth and white. Beautiful Holy Water fonts have been made from these white-lined shells. On some of the East Indian islands where rock is lacking, the natives use the shells for making knives and axes. See also CLAM.

GIANT SALAMANDER, the common name for a species (*Cryptobranchus japonicus*) of Japanese tailed amphibian, which is much like the common American hellbender. This creature is the largest living amphibian, sometimes reaching a length of 5 ft. It lives in cool streams and feeds on other aquatic animals. The Japanese consider its flesh good food, and fish for it with a baited hook.

GIANT'S CAUSEWAY, a famous promontory or platform extending into the sea on the north coast of County Antrim, Ireland. Lying on the margin of a dissected lava plateau, whose cliffs, 500 ft. high, descend sharply to the sea, the formation presents a striking example of the peculiar columnar structure of basaltic rocks. Similar structures are Fingal's Cave in Scotland and the palisades of the Hudson River

in the United States. Whin-dykes divide the platform into the Little, the Middle, or Honeycomb, and the Grand Causeways. The last, varying in width from 20 to 40 ft., forms a rough promenade some 300 ft. long, its floor marked by the joints of the closely fitted, usually hexagonal pillars composing it. Many adjoining cliffs exhibit a similar colonnade structure, and the coast scenery is of notable magnificence.

GIANT STARS, a rather loose description, applied to such STARS as are much brighter, or much larger than the sun.

GIAUR or **GIAOUR**, a Turkish term used as an equivalent of the Arabic *kafir*, or unbeliever, i.e., non-Moslem. In Turkey the term was applied, by force of circumstances, to Christians in particular. In Persia the word is *geber* (from the Persian pronunciation, perhaps, of *gawr*) and is applied to the small remnant of Zoroastrians (less than 10,000) in that land (in India, called Parsis).

GIBBON, EDWARD (1737-94), English historian, was born at Putney, Apr. 27, 1737. A victim of ill-health, he spent a miserable boyhood, picking up some education at local schools and at Westminster School and Magdalen College, Oxford, where he was converted to Roman Catholicism. Sent by his father to Lausanne, he spent five years under Calvinist influences and was reconverted to the Protestant faith. In Switzerland he met and became engaged to Suzanne Curchod; but his father forbade the match, and the girl later married M. Jacques Necker, the French statesman, and became the mother of Madame de Staël. In 1764, Gibbon was sitting within the ruins of the Capitol at Rome, when he conceived the idea of writing *The Decline and Fall of the Roman Empire*. This masterpiece of history was started in 1772, after some years of study, being published volume by volume as finished. Meanwhile, Gibbon entered Parliament in 1774, continuing for eight sessions. In 1779 he was appointed a member of the Board of Trade, but three years later, the post was abolished. Gibbon gave up politics and went to live with his friend Georges Deyverdun at Lausanne in 1783, where he finished his great work on the Roman Empire in 1787, the final volumes appearing in 1788. Gout and dropsy affected Gibbon in his later years, and he died on Jan. 16, 1794, on a visit to London. *The Decline and Fall of the Roman Empire* is Gibbon's monument. Majestic, lucid, sardonic, and comprehensive, the history reveals a supreme literary genius.

GIBBON, an ape of the genus *Hylobates*. The gibbons are the most inferior of the anthropoid apes, with affinities to the catarrhine monkeys. They inhabit the forests of the Indo-Malayan region, and are slender, monkey-like creatures with wholly arboreal habits, remarkable for the length of their arms which, when they stand erect, reach the ground, and by which they travel, swinging by them from tree to tree with great speed. The largest is the Sumatran siamang, 3 ft. tall, and covered with black,

shaggy hair. Other noticeable species are the hooleck of the Himalayan foothills; the lar of Malaya; the gray wauwau of Java and Borneo, and the Sumatran ongka. Gibbons utter weird, howling cries, and many superstitious notions are connected with them; they are gentle, however, easily tamed, and can walk erect.

GIBBONS, JAMES (1834-1921), American cardinal, was born at Baltimore, Md., July 23, 1834. Although he passed his childhood in Ireland, he returned to America at 14 years of age and resided at New Orleans. He was educated at St. Charles College, then at Ellicott City, and St. Mary's Seminary, Baltimore, and was ordained priest in 1861. After a short pastorate at Canton, near Baltimore, he became secretary to Archbishop Spalding and chancellor of the archdiocese. In 1866 he was assistant chancellor at the Plenary Council in Baltimore, and two years later was made titular bishop of Adramytum and created vicar-apostolic of North Carolina. In 1872 he was transferred to the see of Richmond, Va., but in 1877 was made coadjutor to Archbishop Bayley of Baltimore, whom he succeeded that same year. He was elevated to the cardinalate in 1886. As an author he is best known by his *The Faith of Our Fathers*, *Our Christian Heritage* and *The Ambassador of Christ*. He died in Baltimore Mar. 24, 1921.

GIBBONS VS. OGDEN, a litigation in which the decision of Chief Justice Marshall of the United States Supreme Court established a precedent for federal regulation of commerce. The case concerned a grant made by the legislature of New York to ROBERT R. LIVINGSTON and ROBERT FULTON of the exclusive right to steamboat navigation on waters within the jurisdiction of the state. The view of STRICT CONSTRUCTIONISTS was that the congressional power to regulate commerce referred only to the vessels and goods in foreign and interstate trade; but Marshall, rendering his decision in 1824, held that the congressional power was complete and exclusive over every species of commercial intercourse and to the rules for carrying on that intercourse, and that, since the New York law conflicted with a Federal statute relating to the licensing of boats on inland rivers, the grant of navigation rights by the state legislature was declared void.

GIBBS, SIR PHILIP (1877-), British author and journalist, was born May 1, 1877, and educated privately. He entered journalism in 1902, serving on the London *Daily Mail*, the *Daily Chronicle* and the *Tribune*. He was war correspondent during the World War, and was knighted in 1920. In 1921-22 Gibbs was editor of the *Review of Reviews*. His many publications include *Venetian Lovers* and *The Individualist*, novels; *Founders of Empire*, *Battles of the Somme* and *The Way to Victory*, historical; and *Facts and Ideas* and *Ten Years After*, essays.

GIBBS-HELMHOLTZ EQUATION, a relation derived from THERMODYNAMICS connecting the electrical energy which may be derived from a cell with the heat effect of the chemical reaction by virtue of

which the cell operates. The relation may be expressed as follows:

$$E = \frac{\Delta H}{nF} + T \frac{dE}{dT}, \text{ or as } nFE = \Delta H + T \frac{d(nFE)}{dT}$$

Here E is the electromotive force of the cell, T is the absolute temperature, nF the number of faradays of electricity passing through the cell, and H the heat absorbed from the surroundings at constant pressure; dE/dT then represents the temperature coefficient of electromotive force.

Imagine a given chemical reaction to be allowed to proceed in two different ways—first in the open air by the production of heat but no work (other than that involved in pushing back the atmosphere), and then, in a separate experiment, by assembling the chemicals in a suitable cell which is allowed to produce electrical energy. At first thought it might be supposed that at least under ideal conditions the quantity of electrical energy produced in the second case would be exactly equal to the quantity of heat energy produced in the first, since the two processes represent simply two different ways of accomplishing the same chemical change. Since, however, when a cell operates there is in general an exchange of heat energy with the surroundings, the fact is that the electrical work (nFE) may be either greater or less than the loss in heat energy of the system (H), depending, as the Gibbs-Helmholtz equation shows, upon the temperature coefficient of electromotive force. L. O. C.

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GIBRALTAR, a fortified town and promontory at the southern extremity of Spain, situated in $36^{\circ} 6'$ N. lat., $5^{\circ} 21'$ W. long., guarding the east entrance to the Strait of Gibraltar. The rock, which is a British crown colony, has an area of $1\frac{7}{8}$ sq. mi., and lies in the Spanish province of Andalusia. The promontory, rising to an extreme height of 1,439 ft., was a Moorish stronghold until the 15th century when it was included in the kingdom of Granada. The British captured Gibraltar in 1704 and it was formally ceded to that power in 1713. Subsequent attacks on the rocks by French and Spanish besieging parties failed to dislodge the English, who in the present century have so fortified the site that it is militarily accepted as commanding the entrance to the Mediterranean. At the base of Gibraltar is the harbor, 440 acres in extent, containing a naval base and coaling-station. The town of Gibraltar is built on the north-west corner of the promontory; the chief buildings are the governor's residence, admiralty office, the Anglican Cathedral, a theater, naval hospital and barracks. Transportation to Spain proper is by a fleet of ferries operating between Gibraltar and Algeciras. The governor, vested with the powers of commander-in-chief, rules jointly with an executive council. Est. pop. 1930, civil, 15,647.

GIBSON, CHARLES DANA (1867-), American artist and illustrator, was born at Roxbury, Mass., Sept. 14, 1867. He studied at the Art Students'

League, New York City, from 1884 to 1885. His pen and ink drawings, of a distinctive style and with a humorous, often satirical touch, won him popularity. Gibson is well-known for his pictures of the so-called "Gibson girl." In 1920 the artist assumed control of the magazine *Life*, where in later years his drawings often appeared.

GIDDINGS, JOSHUA REED (1795-1864), American statesman, was born at Athens, Pa., on Oct. 6, 1795. Moving to Ohio in 1806, he practised law, and served in the state legislature, 1826-28. From 1838 until 1859 he was a member of Congress, affiliated with the Whigs, Free Soilers, and, finally, with the Republicans, and was active in the slavery contests. He held that slavery was an institution of the individual states only, and could not be recognized by the Federal government. In the case of the slaves who escaped from the ship *Creole* in 1841 to British territory he declared in the House that their assumption of freedom "violated no law of the United States." Censured for resolutions thus offered, he resigned from Congress and was immediately re-elected. He was consul-general to Canada from 1861 until the time of his death at Montreal on May 27, 1864.

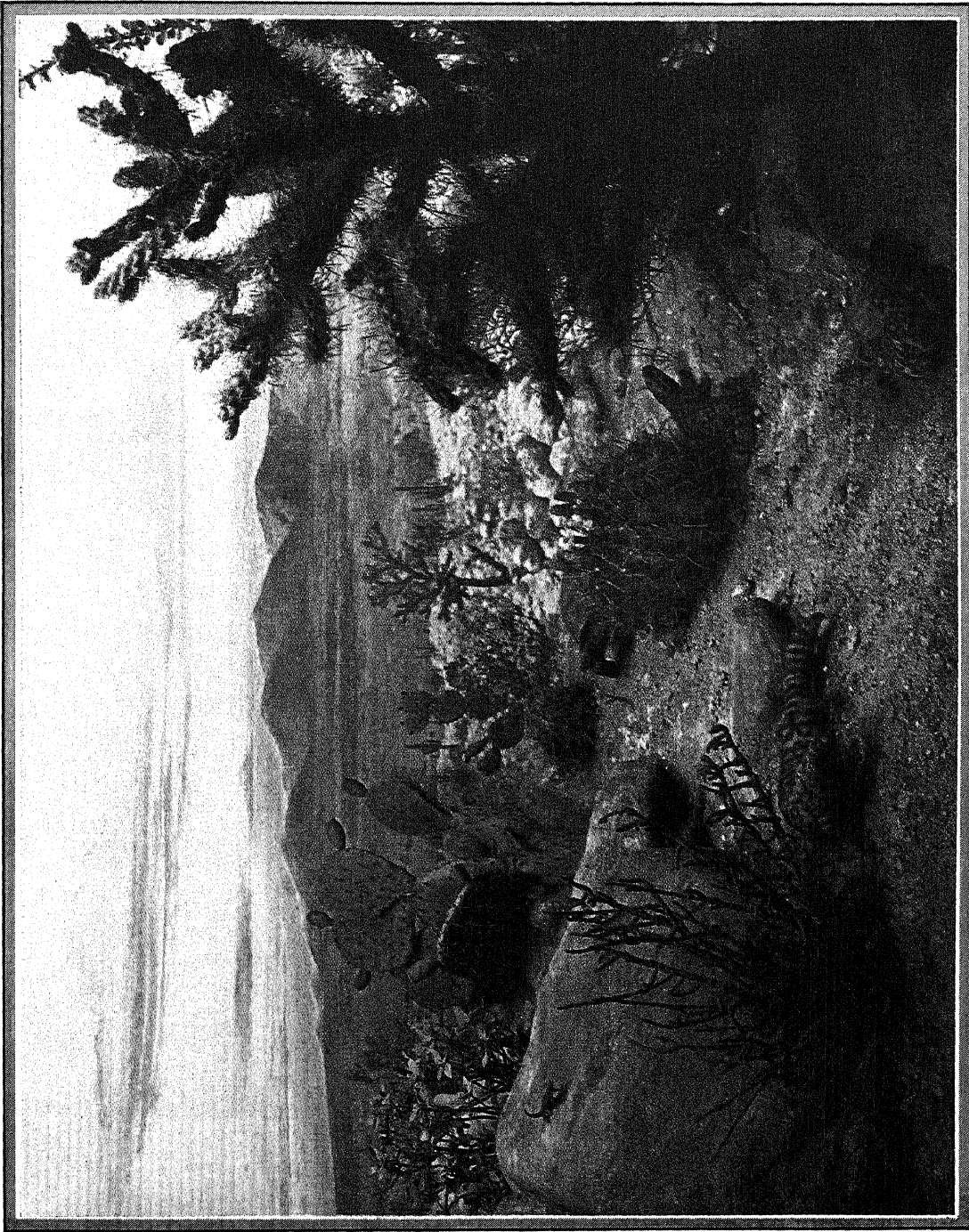
GIDE, ANDRÉ (1869-), French novelist and critic, was born in Paris, Nov. 21, 1869. His best known novels are *L'Immoraliste*, *La Porte Étroite* and *Les Faux Monnayeurs*. His chief volumes of criticism are *Prétexes* and *Nouveaux Prétexes*. Gide's influence over contemporary French writers has been of marked importance.

GIDEON, surnamed Jerubbaal, one of the judges or chieftains of Israel in the premonarchial days, probably the 13th century B.C., is presented as a liberator and religious reformer. He is said to have judged Israel 40 years. Many modern scholars trace in the narratives of his life composite authorship and hold that Gideon and Jerubbaal were two persons whose legends have become combined. It is related in brief in the Bible that Gideon followed a divine impulse to attack the Midianites with his clan. While a spy, he overheard a Midianite soldier tell of a dream of disaster, and returned to his camp, gathered his followers, and with the war cry, "For Jehovah and for Gideon!" completely routed the army of the enemy.

GIessen, a German city in the state of Hesse, situated on the Lahn River about 32 mi. north and west of Frankfurt-on-Main. The old part of the city has crooked streets and quaint houses surrounded by fine gardens in place of the demolished fortifications. Outside, new districts with wide streets have grown up. Giessen has an ancient rathaus and castle and a new castle of 1537, a theater and the university founded by Landgrave Ludwig V in 1607. The chief manufactures are cigars and tobacco, machines and earthenware. Pop. 1925, 33,600.

GIGUE, a lively dance, usually in triple meter, synonymous with the jig. It commonly serves as the last movement of a *SUITE*. The name is derived from the German *geige*, a violin. It is closely related in

GILA MONSTER



COURTESY AMERICAN MUSEUM OF NATURAL HISTORY

GILA MONSTERS OF THE SOUTHWESTERN UNITED STATES

Reproduction of a scene at evening in the Arizona desert. The Gila Monsters, the only poisonous lizards in the world, emerge from the rocks in search of prey. A desert tortoise behind the cactus is searching for a hiding place for the night.

spirit, to the hornpipe, reel, and BOLERO, and varieties of it may be found among all nations.

GIJÓN, a city and port on the north coast of Spain, in the province of Oviedo. It is situated on the neck of the rocky prominence, Santa Catalina. The streets are regular and the buildings substantial. Noteworthy are the 15th century Church of San Pedro, several old palaces, and the Provincial School for Industry and Navigation, founded about 1795. The city has an excellent harbor, whence most of the products of the Asturian mines are exported. It has also its own brick industry and good railroad, street railway and autobus facilities. Est. pop. 1929, 57,000.

GILA CLIFF DWELLINGS, a national monument situated in Catron Co., southwestern New Mexico. A tract of 160 acres was set aside as a government reservation Nov. 16, 1907 and is administered by the Department of Agriculture. The ruins of these cliff dwellings are in an excellent state of preservation. They are divided into small rooms by walls built of adobe and small stones and fill four natural cavities in the overhanging walls of a canyon on the west fork of the Gila River. The cliffs, of a grayish-yellow volcanic formation, are 150 ft. high at this point. From Silver City on a branch of the Atchison, Topeka and Santa Fé railroad and on a U.S. Interstate Highway, a rough trail leads north for 35 mi. through rugged and broken country to the ruins which are accessible only by pack train.

GILA MONSTER, a lizard (*Heloderma suspectum*), found in deserts of Utah, Nevada, Arizona and northwestern Mexico. The other species of the genus (*H. horridum*) is found in central and western Mexico. *Heloderma* is the only genus of venomous lizard known. The poison of the gila monster is poured out along the base of the teeth of the lower jaw and finds its way into the flesh of a bitten victim along grooves in these teeth. The comparative inefficiency of this apparatus accounts for the usual inability of the gila monster to inflict fatal bites on man. The poison is quite as toxic as that of some deadly snakes actually able to inject their venom. The gila monster attains a length of 2 ft. and may be recognized by its short limbs, heavy body, blunt snout and stumpy tail. The head and body are marbled with black and some shade of pink. The pink is sometimes replaced by white or pale yellow. This interesting creature is nocturnal and oviparous. See also LIZARD. C. H. P.

GILA RIVER, a river of New Mexico and Arizona, rising in the Sierra Madre Mountains in the western part of New Mexico. It flows southwest for 130 mi. to the eastern boundary of Arizona and thence generally westward to Yuma where it unites with the Colorado River. Its total length is about 550 mi. The course of the Gila in eastern Arizona is cut through canyons and gorges of mountain country and its lower part flows through level plains which are rapidly being reclaimed by irrigation for agricultural purposes. The Coolidge Dam near San Carlos, completed in 1928,

with a storage capacity of 391,021 million gals., makes possible the cultivation of thousands of acres in southeastern Arizona. About 200 mi. from the mouth of the Gila is the reservation of the Pima and Maricopa Indians. At different points on the river's banks are found ancient ruins indicative of an aboriginal civilization as well as deserted towns from the days of gold and silver mining along the Gila's course. The chief tributaries are the Salt River from the north and the San Pedro from the south.

GILBERT, CASS (1859-), American architect, born at Zanesville, O., Nov. 24, 1859, was educated at the Massachusetts Institute of Technology. He started his work in St. Paul, Minn., but later moved to New York. His most spectacular structure is the Woolworth Building, in which he used the perpendicular Gothic style, designing a structure, which for many years was not only the tallest commercial edifice on earth, but which remained conspicuous for its unique beauty when its height had been surpassed. Prominent among his other buildings are the U.S. Custom House, New York, and the New York Life Insurance Building. Mr. Gilbert also designed the art building and festival hall of the Louisiana Purchase Exposition (St. Louis, 1904), the State Capitols of West Virginia and Minnesota, the Chamber of Commerce and U.S. Treasury annex in Washington, D.C., and many other structures. He was one of the founders of the Architectural League, New York; and served as president of the American Institute of Architects. He was made an honorary corresponding member of the Royal Institute of British Architects, and a knight of the Legion of Honor.

GILBERT, HENRY FRANKLIN BELKNAP (1868-1928), American music composer, was born at Somerville, Mass., Sept. 26, 1868. He studied the violin and composition at the New England Conservatory, Boston, Mass. After playing in several orchestras he went to Europe to study Celtic folk-music. His *Dance in Place Congo*, was produced in 1917 at the Metropolitan Opera, New York. He has composed much orchestral music, and has written articles on primitive and Indian music. He died at Cambridge, Mass., May 19, 1928.

GILBERT, SEYMOUR PARKER (1892-), American lawyer and economist, born at Bloomfield, N.J., Oct. 13, 1892. He graduated from Rutgers and from Harvard Law School, and from 1915 to 1918 was a member of the New York firm of Cravath & Henderson. From 1918-20 he was counsel to the War Loan Staff. He was made under-secretary of the Treasury, in charge of fiscal affairs, at the age of 27, and gained world-wide recognition during 1924-30 as agent general for reparation payments from Germany under the DAWES PLAN. In June 1930 Gilbert returned from Berlin, bringing to a successful close the first six years' operation of the Dawes Plan. In Jan. 1931 he was made a partner of J. P. Morgan & Co.

GILBERT, SIR WILLIAM SCHWENK (1836-1911), English librettist, was born at London, Nov.

18, 1836. He entered the civil service in 1857, practised law and was made a magistrate in 1891. Meanwhile he contributed humorous verse and illustrations to *Fun*, collected as *The Bab Ballads*, 1869. When Gilbert was dramatic critic on the *Illustrated News* he wrote several light plays, and in 1871 began his collaboration with SIR ARTHUR SULLIVAN in their inimitable light operas. Their joint works include *Trial by Jury*, *The Sorcerer*, *H.M.S. Pinafore*, *The Pirates of Penzance*, *Iolanthe*, *The Mikado*, *Ruddigore*, *The Yeoman of the Guard* and *The Gondoliers*. Gilbert was knighted in 1907. He died by drowning at Harrow Weald, Middlesex, May 29, 1911.

GILBERT. See MAGNETIC UNITS.

GILBERT OF SEMPRINGHAM, ST. (c. 1083-1189), wealthy English priest and founder of the Order of the Gilbertines, was born at Sempringham, Lincolnshire, England, about 1083. After studies in France and clerical work under the bishop of Lincoln, he established on his own estates, being "lord of Sempringham," the order known by his name, which with other orders was suppressed by Henry VIII. He died in Feb. 1189, and was canonized by Innocent III. His feast is celebrated on Feb. 11.

GIL BLAS, a picaresque novel of 16th century Spain, by the French author, LE SAGE; published 1735. This very entertaining work, based largely on Spanish romances, is a detailed account of the life of a lively, unscrupulous hero, Gil Blas, who rises through countless adventures from the position of valet to that of being the friend of princes and prime ministers. The various escapades are so planned that the hero in the course of them meets every type of humanity, whether good or bad, obscure or prominent. *Gil Blas* was the model of many later picaresque novels.

GILDER, RICHARD WATSON (1844-1909), American poet and editor, was born in Bordentown, N.J., Feb. 8, 1844, and educated at his father's seminary in Flushing, N.Y. At 26 he became assistant editor of *Scribner's Monthly*, and in 1881, when this publication became *The Century Magazine*, he was made editor in chief, a post he occupied for 28 years. In 1874 he married Helena de Kay, an artist of some note. Gilder was active in civic affairs. As a poet he is best known by his volume of sonnets, *The New Day*, *Lyrics* and *In the Heights*. Gilder died in New York City, Nov. 18, 1909.

GILDERSLEEVE, BASIL LANNEAU (1831-1924), American scholar, was born in Charleston, S.C., Oct. 23, 1831. He was educated at Princeton University and in Germany. A noted classical scholar, he taught Greek and Latin at the University of Virginia, 1856-76, and Greek at Johns Hopkins University, 1876-1915. In 1880 he became editor of the *American Journal of Philology*. Among his works are editions of *Persius*, *The Apologies of Justin Martyr* and *The Olympian and Pythian Odes of Pindar*; in 1909 he published *Hellas and Hesperia*. Gildersleeve died at Baltimore, Md., Jan. 9, 1924.

GILDERSLEEVE, VIRGINIA CROCHERON (1877-), American educator, was born at New York,

N.Y., Oct. 3, 1877. She graduated from Barnard College in 1899 and Columbia University (Ph.D.) in 1908. From 1900-07 she was an instructor in English at Barnard, from 1908-10 assistant professor and during 1910-11 professor. In 1911 she was made dean of the college and through her 20 years of successful administration and her active work in international education has become one of the leading women educators. She was largely responsible for the establishment of the International Federation of University Women in 1919.

GILDS. See GUILDS.

GILEAD, a mountainous region of Palestine east of the Jordan. The geographical location is variously described in the Old Testament but it is generally believed to have been bounded by the Yarmuk, Jordan and Arnon Rivers and by the Arabian desert; it is located in what is now the British Mandate of Transjordan.

GILES, ST. (7th and 8th centuries), patron saint of cripples, is believed to have been a Greek of illustrious Athenian parentage, who emigrated to France in the 7th century. As an anchorite, living in the wilderness near the mouth of the Rhône, and later on the banks of the River Gard, legend states that he was fed by a hind. A monastic establishment grew up about him of which he became the head. Afflicted with lameness, he refused to be cured in order to "mortify the flesh." St. Giles's Church, Cripplegate, London, is named for him. His feast falls on Sept. 1. He died early in the 8th century.

GILIA, a numerous genus of herbs and slightly shrubby plants of the *PHLOX* family. There are more than 100 species native chiefly to the western United



FROM JEPSON. MAN. FL. PLANTS CALIF.. COPYRIGHT

BIRDSEYE GILIA
Lower leaf and flowering stalk

States, several of which are cultivated in flower gardens. They include annuals, biennials and perennials and vary greatly in inflorescence and in the color of their showy flowers. Among those best known in

cultivation are the globe gilia (*G. capitata*), the prickly gilia (*G. californica*), and the birdseye gilia (*G. tricolor*), all natives of California.

GILLESPIE, a city southwest of central Illinois, in Macoupin Co., situated 45 mi. northeast of St. Louis, Mo. It is served by the Big Four Railroad and the Illinois Terminal system. Fruit and livestock are raised in this region, but coal mining is the leading industry and the principal factor in the growth of the city. Pop. 1920, 4,063; 1930, 5,111.

GILLET, FREDERICK HUNTINGTON (1851-) American public official, was born in Westfield, Mass., Oct. 16, 1851. He graduated in 1874 at Amherst and in 1877 at Harvard Law School, and established a practice at Springfield, Mass. In 1892 he became a Republican member of the House of Representatives and was reelected for the 13 succeeding terms. During the last six years of this tenure, from 1919-25, he was Speaker of the House. He was elected to the United States Senate for the term 1925-31 and served on the judiciary and foreign relations committee.

GILLETTE, WILLIAM HOOKER (1855-), American actor and playwright, was born at Hartford, Conn., July 24, 1855. He ran away from home to join a stock company. His next engagement was at the Globe Theatre, Boston, where his greatest success was as Prince Florian in *Broken Hearts*. In 1881 Gillette's play *The Professor* was produced in New York City. Later he adapted *The Private Secretary*, 1884, and wrote *Too Much Johnson*, *She* and a notably successful Civil War play, *Held by the Enemy*, 1886. Ill-health forced Gillette to retire to North Carolina, where he wrote his finest play, *Secret Service* in 1896. His dramatization of *Sherlock Holmes*, in which he played the title rôle, was produced in New York, 1899, London, 1901, and revived in New York, 1930, in which year he announced his retirement.

GILLINGHAM, a municipal borough of Kent, England, lying on the Medway, about 35 mi. south-east of London. A palace of the Archbishop of Canterbury was once located here. The Church of St. Mary Magdalene, blending the Early English, Perpendicular and Decorated styles, also shows traces of Norman architecture. The population of the city is largely employed in the dockyards of Chatham directly eastward, and in the cement and brick works of the vicinity. Pop. 1921, 58,361; 1931, 60,983.

GILLYFLOWER, the name given by early English writers, as Chaucer, Spencer and Shakespeare, to the CARNATION or clove-pink (*Dianthus Caryophyllus*). The name has also been applied to the WALLFLOWER (*Cheiranthus Cheiri*), the STOCK (*Mathiola incana*), the dames-violet (*Hesperis matronalis*), the CUCKOO-FLOWER or ragged-robin (*Lychnis Flos-cuculi*), and various other plants.

GILMAN, CHARLOTTE PERKINS (1860-), American author and lecturer, was born at Hartford, Conn., July 3, 1860. From the year 1890 she lectured and wrote on economics, sociology and ethics, and identified herself especially with labor and femin-

ist movements. She made several public speaking tours in Europe. She was editor of the *Forerunner*, 1909-16, and was the author of a number of books, including *Woman and Economics*, 1898, *The Home, Its Work and Influence*, 1903, *Human Work*, 1904, and *The Man-Made World*, 1910. Her lectures on *The Larger Feminism* in 1913 attracted much public notice.

GILMAN, DANIEL COIT (1831-1908), American educator, was born at Norwich, Conn., July 6, 1831. After graduating from Yale University in 1852 he took post graduate work there, at Harvard and the University of Berlin. From 1856-65 he was librarian at Yale, and during this period he was secretary of the Connecticut State Board of Education and associated with HENRY BARNARD in publishing the *Connecticut Common School Journal*. Gilman was secretary of the governing board of the Sheffield Scientific School 1865-72 and during a part of that time professor of physical and political geography at Yale. From 1872-75 he was president of the University of California and reorganized and greatly enlarged that institution. He was then invited to plan the development of Johns Hopkins University and was appointed its first president, serving until 1901. The next three years he was president of the CARNEGIE INSTITUTION OF WASHINGTON. Gilman was interested in civic and philanthropic movements and participated in these, serving as a commissioner to settle the boundary line dispute between Venezuela and British Guiana, and as president of the National Civil Service Reform League 1901-07. He died Oct. 13, 1908.

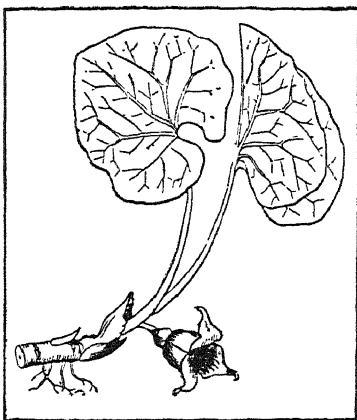
See F. Franklin, *Life of Daniel Coit Gilman*, 1910.

GILPIN, JOHN. See JOHN GILPIN.

GINGER (*Zingiber officinale*), a perennial plant of the ginger family (*Zingiberaceae*), valued for its pungent, spicy tuberous rootstocks. The plant, no longer known in the wild state, is believed to have been native to the warmer parts of Asia or the Pacific islands, whence it has spread by cultivation to most tropical countries. Ginger is a somewhat reedlike plant, with stems 3 to 4 ft. high, bearing two rows of narrow glossy leaves. The yellowish-purple flowers are borne in conelike clusters at the end of separate stems. The plant, however, rarely blossoms and the fruit is unknown. When dried the fleshy rootstock is the ginger of commerce, which is marketed in two forms, coated or black ginger and uncoated or white ginger. Black ginger is the unpeeled rootstock, washed and dried in the sun. White ginger is prepared by peeling, drying and bleaching the rootstocks. The chief uses of ginger are as a condiment and spice and as an aromatic stimulant in medicine. The young green rootstocks, preserved in syrup or candied in sugar, making delicious confections, are exported from China and the West Indies.

GINGER, WILD, the name given in the United States to various species of the genus *Asarum* belonging to the birthwort family, known also as asarabacca. They are stemless, perennial, woodland herbs with aromatic creeping rootstocks which give

rise to 1 or 2 long-stalked heart-shaped or kidney-shaped leaves. Borne close to the ground and half concealed by the foliage is a small, solitary, purple-brown or mottled flower.



CANADA WILD GINGER
Asarum canadense

GINKGO (*Ginkgo biloba*), a beautiful tree of remarkable form and foliage, somewhat allied to the conifers, called also maidenhair tree. The ginkgo has for many centuries been preserved as a sacred object in Chinese temple gardens and is now extensively planted as an ornamental in mild climates throughout the world. In the United States it is grown in the open as far north as the Great Lakes, thriving well, for example, in the public parks of New York City and Washington.

The tree, which sometimes attains a height of 100 ft., bears a few widely spreading branches and broad, fan-shaped, parallel-veined leaves, 2 to 4 in. across, in appearance suggesting greatly magnified leaflets of the maidenhair fern. Before falling in autumn the leaves assume a rich yellow color. The peculiar drupe-like fruit consists of a fleshy, ill-smelling outer portion and an inner woody-shelled nut, about an inch long, containing a sweet, oily, edible seed. Although inferior in quality to the staple nuts of commerce, ginkgo nuts form an article of trade in China.

Botanically, the ginkgo is of unusual interest. It is the only known living representative of an important group of maidenhair trees (*Ginkgophyta*) which had their origin in late Palaeozoic times, attained their greatest abundance in the Jurassic period and have continued in various species, some of which are scarcely distinguishable from the existing ginkgo, down to the present era. F. H. Knowlton enumerates upwards of 10 fossil species of ginkgo found from Alaska to Greenland and southward to Oregon and Wyoming. The ginkgo is probably the oldest tree now living, having existed practically unchanged for perhaps ten million years. See GYMNOSPERMS.

GINN, EDWIN (1838-1914), American publisher, was born on a farm at Orland, Me., Feb. 14, 1838. Ill-health kept him from school a greater part of the time but he graduated in 1862 at Tufts college. Then he became a traveling book agent and by 1867

established his own company in Boston. He was especially successful with textbooks from the time of his first publication, Allen's *Latin Grammar*. He soon admitted his brother, Frederick, as a partner and they became one of the leading textbook publishers of the entire country. Out of the wealth he accumulated, Ginn gave \$1,000,000 in 1919 to endow a World Peace Foundation. He died at Winchester, Mass., Jan. 21, 1914.

GINSENG, a reputed drug plant long used by the Chinese as a fancied cure for impotence. It was originally secured from the root of a Korean herb (*Panax Schinseng*) but a similar North American plant (*P. quinquefolium*), is also used. Neither has any medicinal value, but still command a high price in China. The trade in ginseng roots is so extensive that wild sources are much depleted, and both species are cultivated. Its therapeutic value may be judged by the fact that roots resembling a man's body are thought to be especially efficacious. The ginseng plants are perennial herbs with palmately-compound leaves, small, greenish flowers, followed by red berries. Being woodland plants, most ginseng plantations are successful only under artificial shade. N. T.

GIOCONDA, LA, an opera in four acts by AMILCARE PONCHIELLI, libretto founded on VICTOR HUGO's *Angelo* by Arrigo Boïto; première, Milan, 1876, London and New York, 1883. Although Ponchielli was the teacher of Giacomo Puccini, the master was less successful than the pupil in producing operas that find wide favor with the public; *La Gioconda* is the only opera by Ponchielli which achieved popularity.

The opera is laid in seventeenth-century Venice. A ballad-singer, La Gioconda, attracts the eye of Barnaba, a spy for the heads of the Inquisition. He attempts to embrace her, but help is summoned by her blind mother, La Cieca. The spy turns the tables on the blind woman by accusing her of witchcraft before the crowd, whose suspicions are aroused. She is saved from the mob, however, by the intervention of Enzo Grimaldo, a noble whom La Gioconda loves. But Grimaldo is in love with Laura, wife of the Grand Duke Alvise, a high official of the Inquisition. The spy Barnaba, seeking revenge, writes a letter to Alvise, disclosing the affair between his wife and Grimaldo. The letter is stolen by La Gioconda, who thus learns of the proposed elopement of the young nobleman and Laura. Mad with jealousy she drags Laura from Grimaldo's ship. Grimaldo escapes from the ship, and in disguise appears at a party staged by the Grand Duke, at which Alvise proposes to force his wife Laura to drink a deadly poison, in punishment for her infidelity. Realizing the futility of her love, La Gioconda takes pity upon the lovers, and after learning of the plans of the Grand Duke, succeeds in substituting a harmless narcotic for the fatal poison. She enlists the aid of the spy Barnaba, promising to become his on condition that he help Grimaldo and Laura to escape. The lovers succeed in fleeing the Grand Duke, and Barnaba comes to claim his reward

from La Gioconda. The ballad-singer stabs herself, content that at least she has made happiness possible for Grimaldo.

GIOLITTI, GIOVANNI (1842-1928), Italian statesman, was born on Oct. 27, 1842 at Mondovì, Province of Cuneo, Italy. He studied law at the University of Turin, and after graduation was admitted to the bar. He developed a good legal practice and held official positions in Rome. He was elected deputy in 1882 and became premier in 1892. After a year and a half in office he was forced to resign, owing to financial scandals. He then left Italy, and took no active part in politics for several years. He returned to political prominence on the wave of Socialism that swept Italy in the first part of the 20th century. He was minister of the interior in the Socialist Zanardelli cabinet, and himself became premier in 1903. Because of measures that were taken to suppress labor disorders, Giolitti lost Socialist support and resigned in 1905. He became premier again in 1906, holding that office until Dec. 1909. He returned to the head of the government for the fourth time in 1911, his most important acts in the period of this ministry being the passage of a new electoral law that increased the number of voters from 3,000,000 to 8,000,000 and the conduct of war in Tripoli. He resigned the premiership in Mar. 1914, but when the World War broke out he exerted his personal influence on the ministry to keep Italy neutral. He played a relatively unimportant political rôle during the war, but upon its conclusion he returned to prominence and formed his fifth cabinet in Jan. 1920. During the social unrest of 1920 he did little to curb the activity of the Socialists, believing that they would hang themselves with too much rope, except to allow the Fascists to prevent the occupation of factories. In foreign affairs he negotiated the Treaty of Rapallo in 1920 concerning the problem of the Adriatic. He resigned in 1921, being succeeded by Boromi. At first, after the Fascist *coup d'état*, he expressed approval of the new régime, but went over to the opposition after the murder of Matteotti. He was reelected deputy in 1924, but accomplished very little in the face of Fascism.

BIBLIOGRAPHY.—G. Giolitti, *Memorie della mia vita*, 1922.

GIORDANO, COMMENDATORE UMBERTO (1867-), Italian music composer, was born at Foggia, Aug. 26, 1867. He received his musical education at the Naples Conservatory. His best known operas are *Andrea Chénier*, given at La Scala, Milan, in 1896; *Siberia*, produced at La Scala in 1903, and *Madame Sans-Gêne*, given at the Metropolitan Opera, New York, in 1915.

GIORGIONE (c. 1477-1510), Venetian painter, was born at Castelfranco about 1477, of humble parentage. Little is known of his life, except that he was a pupil of Giovanni Bellini. He may also have worked with Titian; at least he followed that master's technique closely. At the most, there are only eight or ten extant paintings by Giorgione. The most important of the early works is the *Madonna with Saints*, painted in 1504 for the cathedral of Castel-

franco. The *Portrait of a Knight of Malta*, at Florence, and the *Sleeping Venus*, at Dresden, demonstrate the magic brush work and rhythmic line of Giorgione's middle period. The nudes of the late canvases, such as the *Concert*, at the Louvre, Paris, are fuller of form but retain their light and glowing flesh tints. Giorgione transformed painting by his rendition of the poetry of light. His color was harmonious and splendid, his handling large and free. Living at a time when landscapes, as such, were not permitted, he created what has been termed the "mood picture," i.e., a landscape with figures, which by its gay, tranquil or sinister aspect, expresses the feeling of the exquisite creatures who wander within it. Giorgione was an accomplished musician and his canvases can best be described as symphonies in paint. He died of the plague in Venice, in 1510.

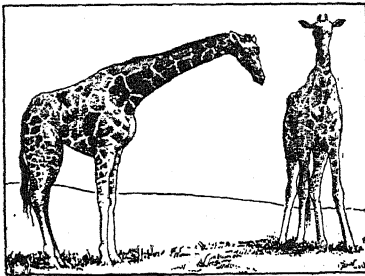
GIOTTO or GIOTTO DI BONDONE (c. 1267-1337), Italian fresco painter and architect, the founder of the FLORENTINE SCHOOL OF PAINTING, was born at Vespignano, near Florence, c. 1267. Vasari claimed that he was a pupil of Cimabue, but later authorities accredit his early training to the Roman mosaicist, Cavallini. Giotto executed three great fresco series. The first, which represents scenes from the life of St. Francis, is in the Lower Church of San Francesco at Assisi. Here the artist's shrewd realism, dramatic power and superb linear design are already evident. The triple tier of frescos in the Arena Chapel, Padua, erected in 1306, include a *Last Judgment*, *Christ in Glory* and scenes from the Old and New Testament, together with symbolic, monochrome figures of Vices and Virtues. Also from the life of St. Francis are the splendid frescoes in the Bardi Chapel in the church of Santa Croce, Florence, executed between 1317 and 1334. In all of them Giotto reveals himself as an incomparable controller of space and composer upon a grand scale. As befitted a decorator of large wall areas, he saw only essentials; his faces are generalized, but his gestures are capable of expressing any emotion, and his figures were the first to give a sense of real mass existing in space. In the Chapel of the Bargello are the frescoes of the Paradiso and the Inferno. The portrait of Dante is here introduced, thus adding portraiture to Giotto's long list of contributions to Italian painting. His most renowned murals are perhaps those in the Arena Chapel at Padua, depicting scenes from the life of the Virgin and of Christ. Giotto died at Florence, Jan. 8, 1337, shortly after the completion of the exquisite Campanile for the Cathedral of Santa Maria del Fiore, Florence. See also FRESCO; GIOTTO'S TOWER.

GIOTTO'S TOWER, a beautiful Italian Gothic campanile or bell tower in Florence, Italy, adjoining the cathedral. It was begun by Giotto in 1334 and completed in 1384 by Andrea Pisano and Francesco Talenti. It is a graceful, rectangular structure, 276 ft. high, consisting of four unequal stories. Its sides are sheathed in colored marble, and its windows, which increase in size with the ascending stories, are noted for their traceries. The statues in the first story

are by DONATELLO and Rosso. Below them are two admirable series of bas-reliefs, one depicting the arts and industries, the work of Giotto and Pisano, the other by LUCA DELLA ROBBIA.

GIRADOUX, JEAN (1882-), French novelist, was born at Bellac, Oct. 29, 1882. He held various appointments in the Ministry of Foreign Affairs. In 1911 he published *L'École des indifférents*, the first of his impressionistic novels. During the World War he was in Alsace and the Dardanelles, and was later sent on missions to America, which provided him with material for *Retour d'Alsace*, 1917, and *Amica americana*, 1919. His sensationally successful novels, *Suzanne et le Pacifique*, 1918, and *Siegfried et le limousin*, 1922, were followed by *Bella*, 1926, full of political allusions, and its sequel *Eglantine*, 1927. *Amphitryon* 38, 1929, was equally notable.

GIRAFFE, a ruminant of the family *Giraffidae*, classified between the antelopes and the deer; a camelopard. This is the tallest of all mammals, having very long legs and a neck lifting the head of some



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GIRAFFE

old males 18 ft. above the ground. The head is small, narrow, and bears on the crown in both sexes short bony horns covered with hairy skin. The body is short, sloping down from shoulders to hips, and the skin is an inch thick. Two species are recognized, the most familiar being *Giraffa camelopardalis* of central and southern Africa, the other, *Giraffa reticulata*, of Nubia and Egypt. The southern one is chocolate-brown in ground-color, the northern chestnut, beautifully ornamented in both species by a network of white lines.

Giraffes inhabit only open country abounding in mimosa and acacia trees, the leaves and tender twigs of which, plucked from the topmost branches, form their only food; they drink rarely. They go about in small bands, can gallop at high speed for short distances, defend themselves only by powerful kicks, as against lions and other enemies, and are very keen-sighted. The negroes kill them by various artifices for the sake of the hide as well as for meat. Because of their extraordinary form and coloring, these animals have been desired since antiquity, especially in the Far East, for exhibition purposes by rulers and more lately by zoological gardens, where they may do well under careful attention, even in cool climates, and breed freely. See OKAPI.

GIRALDA, an ancient bell tower, the lower part of which up to a height of 250 ft. was built by the Moors late in the 12th century. It stands at the north-east corner of the great cathedral in Seville, Spain. The present height is about 300 ft. By means of inclined planes instead of stairs, visitors ascend the tower, which affords a fine view of the city. The original tower clock, the first in Spain, was replaced by another in 1568, but the present clock dates from 1765. On the top stage there is an immense bronze figure of Faith bearing a huge Roman shield, about 13 ft. high and weighing 2,800 lbs., which is so perfectly balanced that it turns with every wind.

GIRARD, JEAN BAPTISTE (1765-1850), Swiss educator, known as Le Pere Girard, was born in Fribourg, Switzerland, Dec. 17, 1765. At 16 he entered the Franciscan order of fathers, by whom he was educated, and in 1804 began teaching in the public schools of Fribourg. After 19 years of service there, and 11 years at Lucerne, he retired in 1834 to write on educational methods. The system Girard advocated, and which was widely applied, was to teach by arousing the pupil's reasoning faculties in contrast to presenting facts and rules. He died in Fribourg, Mar. 6, 1850.

GIRARD, STEPHEN (1750-1831), American merchant, banker, and philanthropist, was born near Bordeaux, France, May 20, 1750, and settled in Philadelphia in 1776. He acquired wealth as a ship-owner and merchant and later became a banker, establishing the Bank of Stephen Girard in 1812. Eccentric, and somewhat of a bigoted free-thinker, Girard was generous, courageous, and forward-looking in his gifts to and work for others. During yellow fever epidemics in Philadelphia in 1793 and 1797-98, he personally toiled among the sick poor. After considerable financial aid to the United States Government in 1812, Girard took 95% of the war loans of 1814. His will bequeathed practically all his fortune to education and philanthropy, notably to the foundation of an industrial and college preparatory institution for poor boys in Philadelphia, known as Girard College. He died in Philadelphia, Dec. 26, 1831.

GIRARD, a city in Trumbull county, northeastern Ohio, situated on the Mahoning River, 5 mi. northwest of Youngstown. The city is a railroad center, served by four lines, and has large steel mills and leather factories. Near by are Mill Creek and Nelson Ledges parks, spots of unusual beauty. President William McKinley was born 5 miles from here. Girard was settled in 1803; and incorporated in 1893. The city has a handsome 50-acre public park. Pop. 1920, 6,556; 1930, 9,859.

GIRARD COLLEGE, a non-sectarian school for orphaned boys, at Philadelphia, Pa., founded under the will of Stephen Girard (1750-1831) in 1831 and opened in 1848. The school admits boys from 6 to 10 years old. Through its primary school, grammar school and high school it prepares its students either for college or for industrial or business careers. Its

productive funds in 1931 amounted to \$85,000,000. The most noted building, designed by Thomas U. Walter, is in the form of a Greek temple. The library contains 30,000 volumes. In 1931-32 Girard enrolled 1,720 students and had a teaching staff of 107, headed by Pres. Cheesman A. Herrick.

GIRDERS, a term usually applied to spans made with solid steel web plates, to which angle flanges have been riveted along the edges, and vertical stiffener angles between the flanges. The length of such spans is usually limited to about 100 feet. Quite large girders are now rolled by steel mills, with the web and flanges in one piece. **TRUSSES** are often termed girders, especially when not longer than one hundred and fifty feet.

GIRGENTI, formerly the name of Agrigento, a city of Sicily. See **AGRIGENTUM**.

GIRL OF THE GOLDEN WEST, THE, an opera in three acts by GIACOMO PUCCINI, libretto (after the play by DAVID BELASCO) by Civini and Zangarini; première, New York, 1910. The Italian composer's attempt to evoke the atmosphere of California is not altogether successful, but the opera has had a certain vogue. The Italian title is *La Fanciulla del West*.

Rance, a sheriff on the trail of the outlaw Ramerrez, is in love with Minnie, who does not return his feelings. She has her eye on Dick Johnson whom she invites to her cabin, little knowing that he is the hunted Ramerrez. While alone together in the cabin they hear voices outside; and Minnie, not wishing to be discovered with her lover, hides him. At the same moment Rance and his aides enter in pursuit of Ramerrez, and they warn her that Johnson is his alias. When the crowd leaves, Johnson confesses his identity and is denounced by Minnie who sends him out into the raging blizzard. Outside there is a shot, and Johnson, wounded, staggers back into the cabin. Minnie hides him a second time just before Rance returns, expecting to find his quarry. The suspicions of the sheriff are temporarily quieted by the girl, but a drop of blood falling from the loft reveals the presence of Ramerrez. Trapped, Minnie extricates herself by proposing a game of cards; if she wins her lover lives, if she loses, she will marry the sheriff. Minnie cheats and wins. Some weeks later Ramerrez has recovered, but he has left Minnie and has been caught by the posse. He is on the point of being hanged when his sweetheart intervenes and saves his life, reminding Rance of his bargain.

GIRL SCOUTS, a national organization similar in character to the Boy Scouts, founded in 1912 by Mrs. Juliette Low of Savannah, Ga., and incorporated in 1915. The central governing body is a National Council affiliated with the Girl Guides of England which organization was the model for the Girl Scouts. The local groups are divided into councils, troops and patrols. Eight girls form a patrol and several patrols are placed under the direction of a captain. There are three grades of membership: the tenderfoot or third class, second class and first class. Promotion from one grade to another is conditioned

upon definite accomplishments. All girls between ten and eighteen are eligible.

Activities have to do with the home, health and citizenship. The slogan "Do a good turn daily" intended to encourage a spirit of helpfulness. The badge of the Girl Scouts is the trefoil, the threefold division of which symbolizes the threefold pledge of every member: "To do her duty to God and her country; to help other people at all times; and to obey the scout law." The membership in 1931 was 236,032.

GIRONDINS or **GIRONDISTES**, a French political party prominent during the FRENCH REVOLUTION. The party was so named after the deputies in the Legislative Assembly from the Gironde department. The Girondins, who foregathered at the salon of Madame Roland, and whose chief leader was Jacques Brissot, in the early stages of the Revolution demanded an extreme republican government and the declaration of war against Austria. In 1793 the Girondins clashed with the JACOBINS, led by Robespierre, and 21 Girondin deputies were guillotined, while others of the party who escaped were hunted throughout France.

GIRTON COLLEGE, a noted institution for women, situated in a village of that name, two miles from Cambridge, England. It was founded in 1869 at Hitchin, in Hertfordshire, by two prominent educationalists, Miss Emily Davies and Mme. Barbara L. Smith Bodichon. Proving successful, it moved in 1873 to Girton, where it henceforth occupied handsome buildings designed by Alfred Waterhouse. The college usually enrolls about 200 students annually. After a term of three years, students are granted degree certificates for the B.A. of Cambridge University. The mistress in 1930 was Miss E. H. Major.

GISSING, GEORGE ROBERT (1857-1903), British novelist and writer, was born at Wakefield, Yorkshire, Nov. 22, 1857. After education in a Quaker school he supported himself by teaching and writing in Liverpool, London and for a time in America. Gissing's first book to attract attention was *Demos*, 1886. He wrote many novels, among them *New Grub Street*, *The Nether World*, *Born in Exile* and *The Odd Women*. *The Private Papers of Henry Ryecroft*, 1903, by which the author is perhaps best known, is largely autobiographical. He died Dec. 28, 1903, at St. Jean-de-Luz, France.

GIULIO ROMANO or **GIULIO PIPPI** (c. 1495-1546), Italian painter, architect and engineer, was born at Rome about 1495. He succeeded his teacher Raphael, as head of the Roman School and with Gianfrancesco Penni finished the four frescoes in the Hall of Constantine in the Vatican, left unfinished by Raphael. In 1524 Giulio went to Mantua, where for 24 years he remained in the services of Federigo Gonzago. Among his many activities were the rebuilding of the Mantua cathedral, the reconstruction and drainage of the streets, the rebuilding of the Palazzo del Te and the decoration of its rooms. His most celebrated work, the oil and fresco series in the Palazzo del Te, *The Story of Psyche*, *Icarus* and *the Titans*.

is typical of the artist who was once called "the prince of decorators." He died at Mantua, Nov. 1, 1546.

GIUSTI, GIUSEPPE (1809-50), Italian poet and patriot, was born in Monsummano, Tuscany, May 12, 1809. Prepared for the law, he turned to literature and became the greatest patriotic poet of his day. His powerful satires in the Tuscan dialect circulated in manuscript and helped to pave the way for the overthrow of the Austrian rule in Italy. These satires, which include *La Ghigliottina a Vapore* and *Gingilino*, lay bare the social and political decadence of the day. Giusti died in Florence, May 31, 1850.

GÎZA, an administrative division of Egypt covering an area of 409 sq. mi. with a population of 591,391 in 1927. Gîza, situated on the left bank of the Nile, about 3 mi. from Cairo, had a population of 26,921 in 1927. The village is notable for the pyramids and the great sphinx which are in the vicinity.

The Gîza group consists of nine pyramids, among them the celebrated three, the pyramid of Cheops, called the Great Pyramid, of Cephren and of Mycerinus. The Great Pyramid's base forms a square, each side of which was originally 768 ft., though now, by the removal of coating, 750 ft. The base occupies 13 acres. The height, originally 480 ft., is now 451 ft. The second pyramid is 690 ft. square and 447 ft. high. The third pyramid, 354 ft. square and 203 ft. high, is the best constructed of the three. The celebrated sphinx, standing 350 yds. southwest of the Great Pyramid, is 66 ft. high and about 172 ft. long, carved from solid rock, it was erected so that it might frighten away evil spirits from nearby pyramid tombs.

GLACE BAY, a port of Cape Breton Co. in Nova Scotia, Canada, on the Atlantic coast, about 213 mi. northeast of Halifax. Rail communication with Sydney 12 mi. distant, facilitates harbor shipping, and there are considerable commercial fisheries. Bituminous coal mines of the surrounding areas are among the most modernized in eastern Canada. In one, a flower garden blooms by electricity a thousand feet below sea level. The local airport is favored by transatlantic flyers; and the Marconi Wireless Station was the first on the North American continent. Glace Bay was founded in 1858. Pop. 1921, 17,007; 1931, 20,704.

GLACIAL PERIOD, refers to the time in the **PLEISTOCENE EPOCH** of earth history when parts of North America and Europe were covered by great sheets of glacial ice. In North America the ice advanced at least five separate times and melted back again, while in Europe six such advances and retreats are recorded. The advances are known as the Jerseyan, Kansan, Illinoian, Iowan and Wisconsin glacial stages in North America, the intervals as the Aftonian, Yarmouth, Sangamon, and Peorian **INTERGLACIAL STAGES**, the present being post-glacial time, with remnants of the glacial period still lingering in Greenland and Antarctica.

In North America the ice sheets had disappeared before man's arrival on that continent, but in Europe he lived through several glacial stages. Efforts have

been made to correlate human cultural stages with the glacial ones, and it is believed by many authorities that the **EOLITHIC** occurred in the second interglacial stage, the lower **PALEOLITHIC** in the third and fourth, and the upper **PALEOLITHIC** in the fifth and sixth



COURTESY AMER. MUS. OF NATL. HISTORY

AREAS GLACIATED DURING THE PLEISTOCENE EPOCH IN NORTH AMERICA

Drawing by Chester A. Reeds

glacial stages. Others push the lower Paleolithic back as far as the second interglacial stage.

The glacial period probably commenced from one to two million years ago, and lasted to within 25,000 to 80,000 years of the present. There have been other continental glaciations in the earth's history, as described under **ICE AGE**. See also **GLACIATION**; **BOULDER CLAY**.

GLACIATION, the mantling of portions of the earth's surface with great masses of ice, called glaciers, as seen in such mountainous regions as the Alps and the Canadian Rockies, or on a more grandiose scale in Greenland and Antarctica. It is the result of such heavy precipitation in cold climates that the warm spells are incapable of melting the snow and ice thus formed. In mountainous regions the ice accumulates in high altitudes until the sheer weight of great thicknesses causes it to creep slowly down hill and valley, like a great viscous mass. Sometimes traveling as much as several feet a day, it is only in the lower altitudes that the tongue of the ever-advancing ice is melted completely away. On its way, rock débris falls from the valley sides and rests on the ice; rock fragments are plucked from the valley sides and bed by being frozen to the glacial ice, where they act like

chisels and sandpaper to scratch, scour and polish the rocky bed. The glacier itself cracks as it moves over its uneven course, forming crevasses which may be hundreds of feet deep. Into these falls more surface débris, so that the ice carries rock fragments, sand and silt scattered throughout its mass. Water melted on its surface percolates downward, to form streams hidden in the body of the glacier, whence they issue at the melting front of the ice tongue. Their burden of ground up rock, "rock flour," frequently gives them a milky appearance.

As the tongue of the glacier melts, the débris carried by the ice is dropped as a heterogeneous mass of unsorted boulders, sand and clay, called variously glacial drift, BOULDER CLAY and TILL. This is known as the MORaine, certain forms of the deposit receiving special names; low, rounded hills are called DRUMLINS, and the long, winding, ridge-like deposits of fairly well-sorted material, dropped by streams under the ice, are known as ESKERS. The stratified deposits of streams flowing out from the glacier's end are called OUTWASH PLAINS. Ground moraine is the débris dropped beneath the body of the glacier; terminal moraine is the material which piles up at the glacier's melting end. Rock and soil which occur on the glacier's surface are known as surface moraine, and may be concentrated along the sides into lateral moraines.

Evidences of action similar to that described for mountain glaciation, but spread widely over the North American continent, lead to the conclusion that tremendous areas were once covered by ice. The same is true of Europe. This condition of continental glaciation was similar to that now observable in Greenland, where the last ICE AGE still lingers. In North America, during the PLEISTOCENE EPOCH, there were three centers of glaciation, in Labrador, west of Hudson's Bay, and in the Canadian Cordillera, where the ice must have accumulated to depths of 4,000 to 8,000 feet to push its edges south to Long Island, the Ohio and Missouri rivers in the east, and into Montana and Oregon in the west. Some regions, in Canada, were swept nearly bare of soil, while others were mantled with glacial drift. In places this was stony and infertile, as in New England, but where the rocks from which it was formed were softer and more thoroughly ground up, it formed good soil, as in the north central States. This deposition of drift profoundly dislocated river systems, and by damming an old valley produced the Great Lakes.

The causes of continental glaciation, a frequent occurrence in the earth's history, are not understood. Variations in the sun's heat might bring about a sufficient refrigeration of the climate to produce it, or shifts in atmospheric and oceanic currents might bring it about at certain places. Some authorities believe it due to shifting of the poles, so that the polar ice caps progressed from place to place. Changes in the carbon dioxide content of the atmosphere, and hence in its heat-blanketing capacity, have also been invoked. Cold climates are also thought to accom-

pany widespread emergence of the continents, and great mountain-building activity. A combination of some or all of these possible causes may suffice to explain glacial climates, or the reasons may yet be undiscovered. *See also* DEPOSITS; EROSION; GLACIAL PERIOD; GLACIER; GEOLOGY; INTERGLACIAL STAGES.

S. F. K.

GLACIER, a mass of slowly flowing ice. Of four recognized types, valley glaciers, piedmont, or composite plateau-glaciers, icecaps, and Continental glaciers, the first is best known.

From mountains lofty enough to harbor perpetual snowfields, like the Alps, the Pyrenees, and Norwegian mountains, icestreams, squeezed out by the pressure of freezing NEVE, descend the valleys. Small glaciers may terminate within a few hundred yards. Average-sized glaciers flow three to five miles to a stream, which drains off their melting waters. The rate of movement varies with the size, from a few inches to several feet a day.

Those giants among Swiss glaciers, the Aletsch, MER DE GLACE and Rhone Glacier, are pigmies beside those of the Alaska coast, several of which discharge their ice into the sea as ICEBERGS. The Muir glacier is 35 miles long, 6 to 10 miles wide, and 900 ft. thick at its front.

Where not snow-covered, glacier ice presents a somewhat jagged surface, crevasses alternating with ridges, or glittering pinnacles of pale sapphire. Aside from the splendor of their mountain setting, the beauty of valley glaciers depends upon the color and clearness of the ice and its comparative freedom from disfiguring MORAINES.

The work of glaciers is rock-transport and erosion. Debris from the valley-walls streaks the iceflow, and is heaped at its front. Boulders and gravel, frozen into the stream, act as teeth in a gigantic file, scratching, grooving, and smoothing underlying bedrock.

Vast continental icesheets, like those of modern Greenland and Antarctica, overrode northern North America and northwestern Europe during the Glacial Period, profoundly altering the topography by erosion and characteristic deposits of GLACIAL DRIFT.

The most accessible of American glaciers are those in Glacier National Park, Montana, and British Columbia. Vast Patagonian and Himalayan glaciers remain virtually unexplored. *See also* DRUMLIN.

GLACIER BAY NATIONAL MONUMENT, situated northwest of Sitka on the southeastern coast of Alaska, was created Feb. 26, 1925 at the instigation of the Ecological Society of America and the National Geographic Society. It comprises 1,820 sq. mi., including Glacier Bay, Bear Track Cove, Bartlett Cove, Excursion Inlet, Lynn Canal, a part of the coast line of North Marble Island, and extends to the international boundary line between Alaska and British Columbia. Several mountains of which Mt. Fairweather, Mt. Lituya, and Mt. La Perouse are the most important, lie within the area of the monument. A number of tidewater glaciers of first rank offer a unique opportunity for the scientific study of their action and of

resultant movement and development of flora and fauna. The region contains valuable remains of ancient interglacial forests. There are also great areas covered with mature forests, areas covered with young trees which had become established since the retreat of the glaciers and vast tracts, now entirely bare, which will be forested within the next one hundred years. George Vancouver, the British navigator, first visited the region of this Monument in 1794 and left an account of it in his *Voyage of Discovery to the North Pacific Ocean and Round the World* (1798). Glacier Bay is reached by boat from Juneau, Alaska.

GLACIER LILY (*Erythronium grandiflorum*), a beautiful plant of the lily family, called also fawn lily, native to high open forests from Montana to Utah and westward to British Columbia and Oregon. It is a low herb, which rises from a deep-seated corm, with two oblong leaves near the middle of the stem and a slender flower-stalk bearing 1 to 6 bright-yellow, nodding, lily-like flowers, 1 to 2 in. long.

GLACIER NATIONAL PARK, one of the most magnificent mountain regions of North America, is situated in northwestern Montana. The park was established by act of Congress, May 11, 1910 and has an area of 1,534 sq. mi. The region was first visited by white men in 1853 when a government engineer, exploring for a railroad route to the Pacific, wandered

of the CONTINENTAL DIVIDE along their crests in a roughly north and south direction, bear glaciers in every hollow. Toward the east the range descends abruptly and forms great cliffs and mountain slopes. The western descent from the Divide is more gentle; several passes cut through the Divide of which four are in practical use as crossing places and others are used only to afford views of the scenic wonders of the opposite side of the park.

There are 19 principal valleys, 7 on the east and 12 on the west, each with countless tributary valleys. Many have not been thoroughly explored and, it is entirely possible, have not been entered except by Blackfoot Indians. All are beautifully wooded below the glacier line and contain exquisite lakes and icy mountain streams which carve their way through wild gorges. Because of its location and accessibility by automobile road, Two Medicine Valley, on the east side, is one of the best known sections of Glacier. The automobile road extends to the Chalets at the lower end of Two Medicine Lake which face a magnificent group of highly colored and elaborately carved and eroded mountains stretching back to the Continental Divide. From Two Medicine Lake, visitors may go by horse or on foot to explore the cirque system west of the lake, climb to Dawson's Pass at the summit of the Divide or take a trail leading up Dry Ford to Cut Bank Pass, one of America's finest scenic spots.

Scattered throughout Glacier Park are 250 known lakes. St. Mary Lake, believed by many to be the most beautiful lake in the world, Two Medicine Lake and Swift Current Lake are the ones usually seen by the more casual visitor. Lake McDonald on the western slope with its heavily wooded shore is the largest lake in the park and was the first to be settled. Many of the finest spectacles of the Rockies as well as of Glacier National Park are within easy distance of this lake by trail; among them the Sperry Glacier, Avalanche Basin, Lake Ellen Wilson with its magnificent cascades into Little St. Mary Lake, Gunsight Pass, and the excellent fishing lakes of Camas Creek Valley. Kintla Valley at the northwestern corner of the park, a region of towering peaks, picturesque lakes and mighty glaciers, is more difficult of access and less frequently visited. It is in many respects the scenic climax of Glacier.

Glaciers. Although 60 is the number of glaciers usually reckoned, there are more than 90, if interesting snow patches, exhibiting most of the characteristics of true glaciers within an area of a few acres, are to be included. The glaciers now found in this region are but meager remains of tremendous ice masses which have advanced and receded through three Ice Ages. Black-foot Glacier is the largest in the park. Its western lobe is easily accessible from Gunsight Pass and enables visitors to study practically all the phenomena of living glaciers within a small area. The Kintla and Agassiz glaciers on either shoulder of Kintla Peak are the next in size.

Travel Routes and Facilities. Hotels, chalets and cottages are operated within the park under



BLACKFOOT SQUAW AND PAPOOSE OF THE GLACIER NATIONAL PARK RESERVATION

by mistake up Myack Creek. The next explorers were surveyors, who in 1861 established the Canadian boundary line which also forms the northern boundary of the park. In 1890 a sporadic copper rush occurred but until the region became a national park it was visited chiefly by big game hunters and lovers of scenery. The great Blackfoot Indian Reservation adjoins the park on the east.

Scenic Features. The name of the park is derived from its 60 glaciers. The Livingston and Lewis ranges form the central backbone of the park. The upper reaches of these tumbled mountains carrying the line

franchise from the Department of the Interior. Eight free automobile camping grounds with running water, sanitary facilities and firewood are maintained for visitors carrying their own camping equipment. Glacier is the foremost trail park in the country and has approximately 800 saddle horses available for visitors during the season which lasts from June 15 to Sept. 15.

Glacier Park Station, Mont., the eastern entrance to the park and Belton, Mont., the western entrance, are on the main transcontinental line of the Great Northern Railway. Both entrances are also reached by a number of well-marked automobile highways.

Educational Features. Educational facilities at Glacier include self-guiding nature trails which have been set up around Swiftcurrent Lake, and in the region of the Lake McDonald Hotel, John's Lake and Fish Lake and also extending from Avalanche Camp to Avalanche Lake. Transplanted exhibits of wild flowers and various other phases of nature study are maintained at Many Glacier, Going-to-the-Sun, Two Medicine, and Lake McDonald. Lectures are given at stated times by the ranger naturalists who also escort field trips and auto caravans.

GLACIER PARK, a Canadian national park established Oct. 10, 1886, area 521 sq. mi. in the Selkirk Range in western British Columbia. The peaks in this region have been worn down almost to the timber line and are crowned with innumerable glaciers making it one of the best centers in America for alpine climbers and students of glacial formation. In this park are the famous Illecillewaet glacier and the Nakimu caves. The caves are subterranean caverns formed by seismic disturbance and by the action of water. They are characterized by beautiful marble markings and are connected at various levels by dark passageways through which streams rush with weird sounds, hence the name Nakimu or "spirit noises." Other outstanding features are the Asulkan glacier, Marion Lake and the Rogers and Baloo passes. From the summit of Mt. Cheops in Cougar Valley, so called because of its supposed resemblance to the Egyptian pyramid, more than 200 glaciers and peaks are visible. Wild life is plentiful. Goat, caribou, deer and bear are numerous and the fur-bearing animals, particularly marten and beaver, are increasing rapidly. The park has luxuriant coniferous forests and beautiful alpine flower gardens. It is traversed by the Canadian Pacific railway and is also reached by motor from YOHO and KOOTENAY parks.

GLADDEN, WASHINGTON (1836-1918), American clergyman, was born at Pottsgrove, Pa., Feb. 11, 1836. He graduated in 1859 from Williams College and held pastorates in New York and Massachusetts until 1882, when he was called to the First Congregational Church at Columbus, O. He remained in this office for 32 years, and then retired as pastor emeritus. His books include *Plain Thoughts on the Art of Living*, 1868, *Present Day Theology*, 1913, and *Live and Learn*, 1914. Gladden died at Columbus, O., July 2, 1918.

GLADIATOR, from Latin *gladius*, a sword, a professional fighting man peculiar to the Romans and borrowed by them from the ancient Etrurians. The first gladiators were captured warriors who fought to the death at the funeral ceremonies of a conquering king or general. Among the Romans, gladiators were criminals, captives or trained slaves. They were turned over to *lanistæ*, or masters of schools, and kept under iron discipline. Gladiators were sworn to fight to the death, and any who showed cowardice were tortured. The presence in Rome of these desperate men often became a menace to the safety of the city. The rebellion led by Spartacus, an escaped slave and gladiator, was not put down for three years.

Under the Empire, fighting in the arena became fashionable. Women entered the contests, and profligate young nobles sought the arena to win back favor and fortune. At least one Emperor, Commodus, fought repeatedly in the arenas. It was also under the Empire that the cost of gladiatorial games rose so high that it threatened to ruin the nation. Caesar spent fortunes in giving games, and later rulers drained the provinces of men, money and animals to keep the Roman populace amused.

The first gladiatorial combats on record were those given by Marius and Decius Brutus on the death of their father in 207 B.C., when two pairs of gladiators fought. But Nero on several occasions gave games lasting many days, and Trajan staged gladiatorial contests that lasted 123 days in which 10,000 men took part. Wherever Rome had a colony, gladiators became a part of the daily life, and arenas were built in every Roman city and province.

Many kinds of arms and armor were used in the combats. Among the common types of gladiators was the Retiarius, a lithe, agile man, who fought practically naked, armed with a net with which to entangle his foe and a trident with which to dispatch him. The gladiators were usually opposed by *Secutors*, or followers, swordsmen clad in complete armor. Smanites carried the oblong Smanite shield, wore plumed helmets and carried swords. The Thraces had a small round shield and a sword curved at the end like a scythe. Mirmillones wore Gallic armor and used the long, straight Gallic sword, while Essedarii fought from British war chariots. Bestarii fought with wild animals, and Dimarchaeri fought with a sword in each hand.

Expert gladiators became public favorites and after a victory were often showered with coins and jewelry. Many such bought their freedom and reaped fortunes. A popular gladiator who survived after many combats might win the wooden sword awarded as evidence that he was retired and free. Defeated gladiators, unless well known for previous victories, were almost invariably killed on the spot by their opponents when the spectators turned their thumbs down in the death sign.

See L. Friedlander, *Die Vorstellungen aus der Sitten geschichte Roms*, translated as *Roman Life and Manners Under the Early Empire*, 4 vols., 1909.

GLADIOLUS, a genus of handsome perennial plants of the iris family. There are about 200 species, native to Mediterranean countries and to tropical and southern Africa. The numerous gladioli in cultivation, which rank among the most showy and important of summer-blooming ornamentals, are the products of a long process of variation and hybridization of a few species. They are erect, vigorous plants, with large cormous roots, usually unbranched stems, 2 to 4 ft. high, strongly nerved, sword-shaped leaves and terminal spikes of handsome blossoms. The flowers, which are somewhat funnel-shaped and from 2 to 8 in. across, vary immensely in color from shades of red, purple and yellow to white. Gladioli, which are insect-free, are of easy cultivation, thriving in any good garden soil. When grown commercially or for cut flowers, the corms and seeds are best planted in rows. The cut flowers, which bear shipping well, keep their freshness for many days.

GLADSTONE, WILLIAM EWART (1809-98), English statesman, born at Liverpool, Dec. 29, 1809, the third son of Sir John Gladstone, who was a friend of Canning and a wealthy merchant who became in time a baronet and member of Parliament. There was, in Gladstone's veins, not a drop of English blood; his father and mother were both Scots by birth and ancestry, the one a Lowlander, the other of Highland descent. He was educated at Eton and at Christ Church College, Oxford. After taking his degree with a double first-class in classics and mathematics, Gladstone left Oxford in the spring of 1833 and went to Italy, whence he was recalled to stand in a parliamentary election. The duke of Newcastle, a leader of the Tory Party, was looking for a candidate who could carry the election in the borough of Newark, which had returned a Radical in the preceding election. Gladstone was recommended to the duke as a young man of promise, partly on the basis of a speech he had made in the Oxford Union against the Reform Bill. He was elected and entered the first reformed parliament in January, 1833. His maiden speech was a defense of the management of his father's West Indian plantation, which had been referred to in proof of the contention that mortality was excessively high among the slaves. Gladstone urged that emancipation be gradual; and he denied that West Indian slavery was attended by severe hardship or a high mortality.

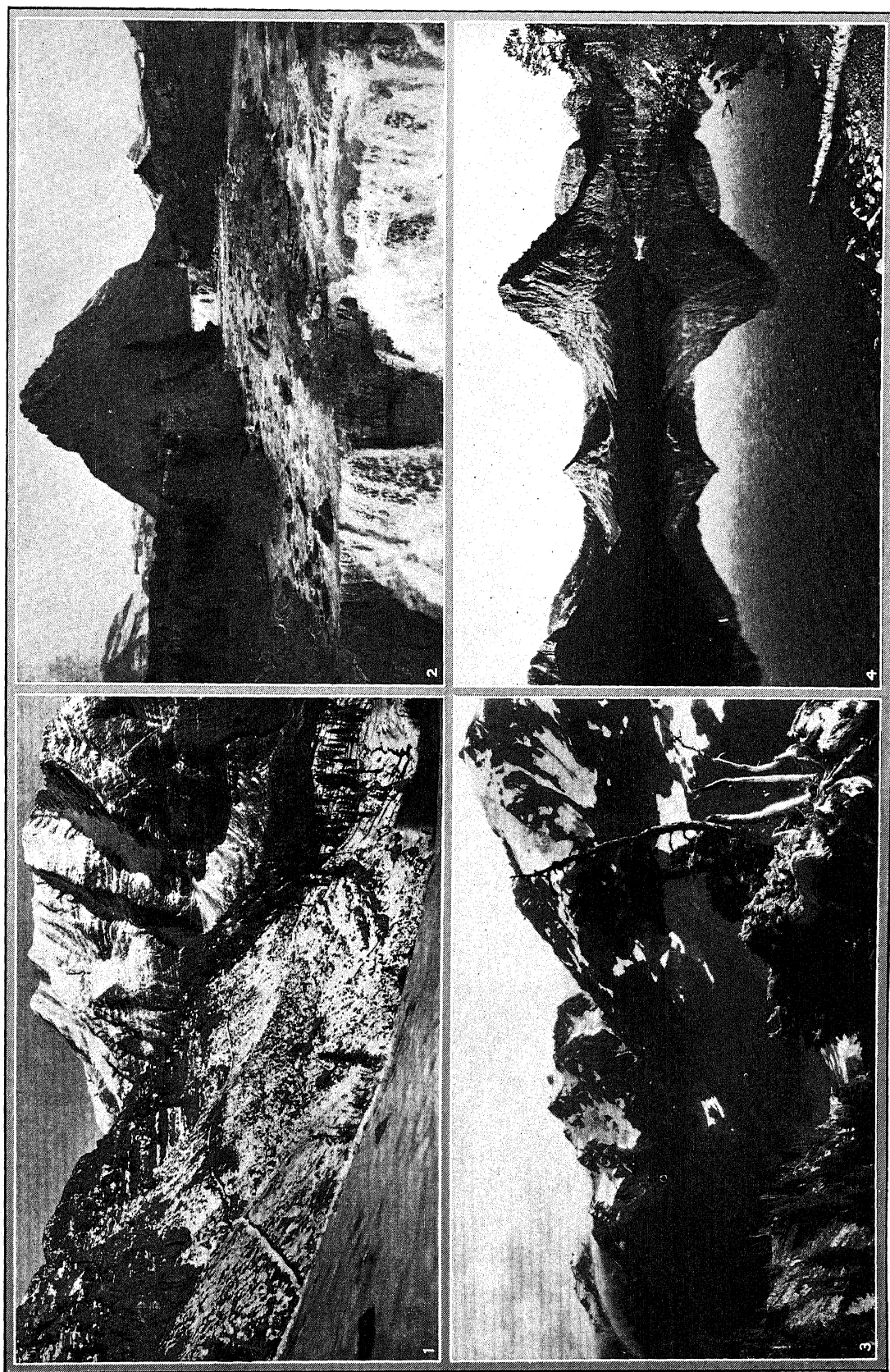
In 1835, Gladstone was under-secretary for the colonies in Sir Robert Peel's short-lived forest administration. When Peel returned to office in 1841, Gladstone was made vice-president of the board of trade; he became president of the board of trade and a member of the cabinet in June 1843. He resigned office at the beginning of 1845 because of disagreement with the government's educational policy in Ireland, but returned to the cabinet at the end of the year as secretary for the colonies. The chief part that Gladstone played in framing the revised tariffs cost him his seat for Newark, because the duke of Newcastle was a high protectionist; but, in 1847, he was

elected to represent the University of Oxford. He had seceded from the Tory Party with the Peelites and, the next few years were a period of transition, in which he was moving in the direction of Liberalism. His unpremeditated attack on Disraeli in 1852 brought about the resignation of the first Derby-Disraeli ministry; and, in the new government, a Whig-Peelite coalition, Gladstone was included as Chancellor of the Exchequer. The five-hour speech with which he introduced his first budget, established Gladstone's position as both an eminent financier and one of the few great parliamentary orators. In 1859, Gladstone virtually brought to an end the separate organization of the Peelites by taking office, in the exchequer, in the Whig government headed by Palmerston. The two men, Palmerston and Gladstone, were, by nature, incompatible; but the latter, who came more and more to represent the left wing of the Whig party, remained in the cabinet throughout the entire administration. Gladstone's opinions cost him, in 1865, his seat for the University of Oxford, but he was returned as a member for South Lancashire.

Gladstone became Prime Minister for the first time in 1868, after the fall of the second Derby-Disraeli ministry. His party, now known as the Liberal, instead of Whig, was divided, but he united it on the question of Ireland. His first administration, 1868-74, was notable for the great amount of constructive legislation which it enacted in varied fields. Among the more important acts were that which disestablished the Church of Ireland, a branch of the Anglican Communion, which numbered among its adherents not more than an eighth of the Irish people; the Elementary Education Act, which provided England, for the first time, with an adequate system of elementary schools; the Universities Test Act, abolishing religious tests at Oxford and Cambridge; the legalization of trade unions; the Ballot Act, which substituted secret voting for oral voting; and the Judicature Act, by which the judiciary was entirely reorganized. In his foreign and colonial policies, Gladstone was less successful; and this fact, combined with the opposition aroused by his numerous and drastic reforms, led to his defeat in the general elections in 1874. It was not until 1880 that Gladstone again became Prime Minister. He had resigned the leadership of the Liberal party, but it was his attack on Disraeli's Turcophile policy that aroused the nation and swept the Conservatives from office, and it was impossible to construct a liberal cabinet without including him, or to include him other than as Prime Minister.

Gladstone's second administration, 1880-85, was largely taken up with the Irish question; but its most notable achievement was the extension of the franchise to agricultural laborers and the redistribution of electoral districts. In Africa and Afghanistan, the government reversed the imperialistic policies of Disraeli; in Egypt, they followed and extended Disraeli's policy. Dissension over the Irish policy weakened the government; its resignation was brought about by national resentment at the fall of Khartoum and Gordon's

GLACIER NATIONAL PARK



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MOUNTAIN RANGES OF THE ROCKIES AND GLACIER NATIONAL PARK

1. Mount Jackson from Lincoln Pass in Glacier National Park. 2. McDermott Falls, Montana, with Grinnell Mountain in background. 3. Christie, Seattle and Queets, left to right, three storm-swept peaks in the Olympic Mountains of northwestern Washington. 4. Medicine Lake and mountain background in Glacier National Park.

death, for which Gladstone was held responsible. Gladstone's third administration lasted only from February to August, 1886. Converted at last to Irish Home Rule, the Prime Minister introduced a bill which split the Liberal party and was defeated in the House of Commons. His fourth administration was almost equally barren. The second Home Rule Bill passed the Commons but was rejected by the Lords in 1893; the following year, Gladstone resigned because of the infirmities of old age.

Of imposing appearance, gifted with a splendid constitution, with a clear and melodious voice and an inexhaustible readiness of speech, Gladstone was one of the greatest figures in the history of the English Parliament. He was a man of great intellectual attainments, a classical scholar of no mean ability, but pre-eminent in the field of public finance. There was a grain of truth in Disraeli's characterization of Gladstone as "a sophisticated rhetorician inebriated by the exuberance of his own verbosity," but no more than a grain. The dominant note in Gladstone's public and private life was moral grandeur, and it was that rather than the richness and variety of his genius that made him the "Grand Old Man." A. H. S.

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GLADSTONE, a city in Delta Co., Michigan, situated in the southern part of the Upper Peninsula, 8 mi. north of Escanaba, on the Little Bay de Nocque. It is served by the Soo Line Railway and by bus, truck and steamboat lines. The local manufactures are principally veneers and guns. The city was settled in 1887 and incorporated in 1889. Pop. 1920, 4,953; 1930, 5,170.

GLAMIS, a village of Forfarshire, Scotland, about 49 mi. directly north of Edinburgh. It is particularly famed for its majestic castle which, standing in dark woodland, is largely of the 17th century, although originally of 11th century foundation. Macbeth was thane of Glamis, and the castle is the traditional, though now discredited, scene of his murderous activities. In the village, however, an ancient sculptured cross still is referred to as "King Malcolm's grave-stone." Pop. 1921, 1,099; 1931, 985.

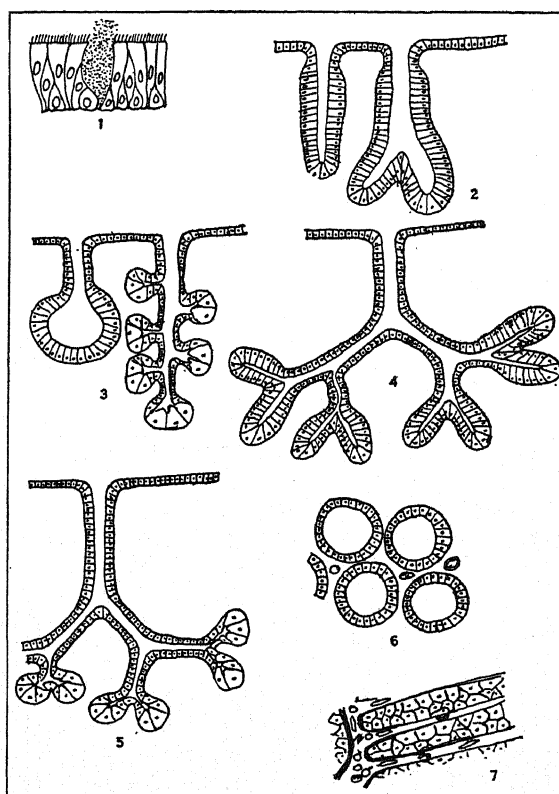
GLAND, a portion of modified EPITHELIUM which elaborates a substance useful to the body or to be excreted from it. The important constituent unit of a gland is the secreting cells. These may be modified in various ways for the production of specific secretions, and arranged variously in the organ.

A gland cell is polyhedral, prismatic, columnar or ovoid in shape. It usually contains a fairly large nucleus which tends to be basal in the cell. The cytoplasm may contain secretion granules, which in the case of digestive glands are termed *zymogen granules*. When the secretion is needed, the granules become transformed into secretion and pass out of the cell. Other glands secrete by loss of a portion of the modified cytoplasm. Still others become transformed

through their death into secretion. Minute passages may sometimes be seen between gland cells. These are secretory capillaries.

Glands have been variously classified, but the most usual system depends upon the branching plan. In the first place, they are divided into exocrine and endocrine glands, according as they do or do not have ducts.

Exocrine glands are simple if their duct is unbranched, or compound if it is branched. If a simple gland is composed of a single cell, as the goblet cells of the bronchi and colon, it is said to be unicellular (Fig. 1). Simple tubular glands (Fig. 2) may consist of a single pit, as the intestinal glands; of a coiled tube, as the sweat glands; or of several pits leading into a common one, as the glands of the stomach. Simple alveolar glands are unbranched glands whose



DIAGRAMS OF TYPES OF GLANDS

Fig. 1, Unicellular; Fig. 2, simple tubular; Fig. 3, simple alveolar; Fig. 4, compound tubular; Fig. 5, compound alveolar; Fig. 6, follicular; Fig. 7, solid cords

terminal secreting portion is rounded and larger than its duct.

Compound glands, like simple ones, may be tubular or alveolar, according to whether their end-pieces form a long tube lined with prismatic cells, or are short and globular with pyramidal cells (Figs. 4, 5). If both types are mixed in a single gland it is termed a compound tubuloalveolar gland.

Endocrine glands consist of secreting portions without ducts, the substance elaborated being discharged into the blood stream. The cells of some, notably the

THYROID, are arranged radially around a central cavity. This is called a follicle (Fig. 6). Others consist of elongated cords surrounded by capillaries into which the secretions are poured.

For discussion of various glands, consult the following articles: BREAST; COLON; ENDOCRINE GLANDS; GENERATIVE ORGANS; INTESTINE; KIDNEY; LIVER; PANCREAS; MOUTH AND SALIVARY GLANDS; SKIN; STOMACH; TESTIS.

W. J. S. K.

GLANDERS, an acute contagious disease affecting the horse, ass and mule, and capable of transmission to man. It is caused by a specific organism, the *Bacillus mallei*, and may be diagnosed by injecting a filtered and sterilized culture of this bacillus.

Glanders especially affects the lungs, the mucous membranes of the organs of respiration and the lymphatic system. When limited to the lymphatics under the skin the disease is called farcy. Both farcy and glanders may be acute or chronic, and the affected animal should immediately be destroyed.

The symptoms are fever, lassitude and unwillingness to move, thirst, loss of appetite and often emaciation. There is a characteristic nasal discharge with small yellow or large ragged ulcers on the nasal membranes. The lymphatics are usually involved and sometimes break discharging pus. Symptoms of pneumonia, pleurisy and extreme lung congestion usually precede death which is due to asphyxia. See FARCY.

GLANDS, USES OF. Glands of domestic animals are obtained as by-products of the packing industry, and extracts prepared from them are widely used in medicine. Among the more important of the many glands so utilized are the thyroid, pituitary, adrenal, pineal, and thymus. The secretions of these and other glands have such varied functions as affecting the rate of life processes, controlling growth, and influencing blood pressure. Nervous functions and reactions are also associated with gland secretions.

Many of the glands are extremely small and several thousands of them are, in some cases, necessary in order to manufacture a single pound of pharmaceutical product. To be suitable for use in human medicine, such preparations necessarily entail rigid inspection of the animals from which they are derived and also a high degree of technical skill to insure purity, potency, and proper standardization. Products of this character should be used only under competent medical direction. D. S. B.

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GLARE, a blinding sensation caused by excessive brightness of light in the field of vision, by extreme contrast between a light source and its surroundings or by continued exposure of the eye to a light source. It is discomforting, interferes with vision and produces eye fatigue.

GLARUS ALPS. See ALPS.

GLASGOW, ELLEN ANDERSON (1874-), American novelist, was born in Richmond, Va., Apr. 22, 1874. Her first novel, *The Voice of the People*, was published in 1900. In her novels Miss Glasgow

has been concerned chiefly with the history of the South during the Reconstruction period, and the position of women. The most representative of her 19 books are *The Battle Ground*, 1902, *The Romance of a Plain Man*, 1909, *Virginia*, 1913, *Barren Ground*, 1925, and *They Stooped to Folly*, 1929.

GLASGOW, the largest and economically the most important city in Scotland and one of the largest in Great Britain. It lies on the Clyde 20 mi. above its mouth. Although founded as early as the 6th century, Glasgow is the newest of Great Britain's large cities, thus, except for churches, all the important public buildings have been erected recently. The sordid tenement houses in the outer sections of other great factory towns are lacking there, as the working people live mostly in the center of the city, where there are no dirty streets. The greater part of the city lies north of the Clyde, where the railroad stations are situated. The principal streets with the finest shops are Argyle, St. Vincent, Sauchiehall, Union and Buchanan streets. On the south side of the river, which is spanned by numerous bridges, lie the newer sections, containing on the eastern side the dwellings of the affluent. Most of the suburbs, including Parteck, Coatbridge, Hamilton, Wishaw and Govan, have been incorporated with the greater city. Still administratively independent, but with the closest economic relations to Glasgow, are Paisley, Renfrew, Motherwell, Dumbarton, Port-Glasgow and Greenock.

George Square, the nucleus of the city, is surrounded by the most important public buildings, the new Town Hall, the Bank of Scotland, the Merchants' House and the Main Post Office. On a high column in the square is the statue of Sir Walter Scott, surrounded by statues of Queen Victoria, the Prince Consort, and those of numerous others important in Scottish history. Toward the east at the foot of a hill in the oldest part of the city is the Early-Gothic cathedral with a fine crypt, surrounded by a graveyard with many monuments, including that of John Knox. On the extreme west beyond the Kelvin Brook and the Kelvingrove Park is the new university building, erected about 1870, one of the finest in the world. Glasgow is the seat of a Roman Catholic archbishop and of an Anglican bishop. The institutions devoted to the public welfare are models of their kind. Sewers were built very early and the water systems cost £5,000,000. The length of the street railways is about 235 mi.

The University, founded in the middle of the 15th century, is attended by many colonials, and with it are closely allied the Library of 250,000 volumes, the Hunterian Museum, founded in 1783 by William Hunter, the Botanical Garden and the Western Infirmary. Near the Kelvingrove Park are the Corporation Art Galleries, one of the finest collections of paintings in Great Britain, as well as the monuments of the famous scientists Lord Kelvin and Lord Lister. Other educational and cultural institutions are the Atheneum, the School of Art and Design, Anderson College and the Royal Technical Institution.

The principal railroad stations are the Central in the center of the city and the Buchanan in the north for the traffic with West Scotland. The shipping is largely with Ireland and Canada. Although the first ocean steamer sailed from the Clyde, Glasgow became an important center of trade and shipping only in recent years, owing to the improvement of the river bed and extensive harbor facilities. The chief imports are grain, meat, cattle, fruit, lumber, metals, eggs, sugar, petroleum and cheese; exports, ships, jute, wool, linen, paper, vehicles and lumber.

Of many industries, iron is the chief, employing 150,000 men. An important branch is shipbuilding. The textile industry is also well developed and there are large chemical, glass, paper, earthenware, sugar and tobacco factories, as well as famous whiskey distilleries. Pop. 1926, 1,113,482; 1931, 1,088,417.

GLASGOW, a city in southwestern Kentucky, the county seat of Barren Co., situated 100 mi. southeast of Louisville. It is served by the Louisville and Nashville Railroad. Tobacco, corn, dairy products and timber are the leading interests of this region. Oil and gas are found near by. Glasgow has flour mills and overall and tobacco factories. The city was founded in 1798. Pop. 1920, 2,559; 1930, 5,042.

GLASGOW, UNIVERSITY OF, at Glasgow, Scotland, a university founded in 1450 by William Turnbull, Bishop of Glasgow. The institution occupied a group of buildings on the High Street from 1460 to 1870, when it transferred to magnificent new buildings, designed by Sir G. G. Scott, in the Early English style, on Gilmore Hill. The students number over 4,500, and of these many are women belonging to either Queen Margaret College, 1883, or Muirhead. Conspicuous among the present buildings are Bute or Common Hall, Randolph Hall, the Hunter Anatomical Museum and the Library, which has 250,000 volumes. The Royal Observatory, on Dowan Hill, is connected with the university, and the Royal Technical College is affiliated with it. Of the university's many scholarships the most noted is the Snell Exhibition, which enables Glasgow to send its distinguished students to Balliol College, Oxford. In 1931 the chancellor was Sir Donald Mac Alider.

GLASPELL, SUSAN (1882-), American writer, was born in Davenport, Iowa, July 1, 1882. She was educated at Drake University (Iowa) and the University of Chicago. She began her literary career as a writer of short stories, some of which have been published in *Lifted Masks*, 1912. After publishing several novels, including *The Glory of the Conquered*, 1909, and *The Visioning*, 1911, the author worked with the Provincetown Players in Provincetown, Mass. She wrote a number of plays, among which are *Trifles*, 1917, *Suppressed Desires*, 1917, and *Alison's House*, 1930, which won the Pulitzer Prize for Drama. Later novels have been *Brook Evans*, 1928, and *Ambrose Holt and Family*, 1931.

GLASS, CARTER (1858-), American publisher and senator, born at Lynchburg, Va., on Jan. 4, 1858. He was educated in public and private schools at

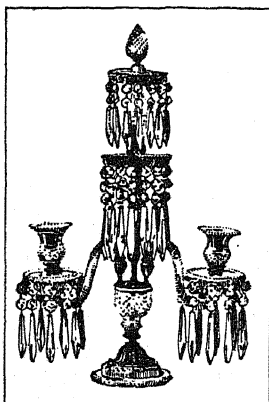
Lynchburg, at Lafayette College, the University of North Carolina and at Washington and Lee University. He decided to learn the printing trade, and spent eight years in the production department of a newspaper. He then secured the proprietorship of two Lynchburg newspapers, the *Daily News* and the *Daily Advance*. He was a member of the state senate, 1899-1903, the state constitutional convention of 1901, and the House of Representatives, 1902-19. As chairman of the House committee on banking and currency he pushed through the Owen-Glass Bill of 1912 which provided for the institution of the Federal Reserve system. He resigned from Congress in 1918 to become secretary of the treasury under WOODROW WILSON. This position he resigned in 1920 to go to the Senate by appointment from the governor of Virginia. He was elected to the Senate in 1920 and reelected in 1926. His service in the upper house was made notable by his grasp of financial problems. In 1932 he sponsored the Glass-Steagall Bill, which had the support of the Hoover administration, in an effort to relieve the financial depression through a modification of the provisions of the Federal Reserve Act governing the rediscounting of commercial paper and the issuing of Federal Reserve notes. He served on the National Democratic Committee from 1916 to 1928, and as chairman of the committee on resolutions in the Democratic convention of 1920 drafted the party platform.

GLASS, MONTAGUE MARSDEN (1877-), American author, was born at Manchester, England, July 23, 1877, and came to New York City in 1890. He studied at New York University and began to practice law, which he abandoned however for a literary career. His first stories about *Potash and Perlmutter*, published in 1910, brought him immediate success, and he continued to use Jewish clothing dealers as the central figures in his stories. Among these are *Abe and Mawruss*, 1911, *Object: Matrimony*, 1916, and *Lucky Numbers*, 1927. Several of Glass's books were successfully dramatized.

GLASS, a manufactured substance, hard and usually transparent or translucent. Though used for the commonest domestic utensils, it is also the medium for an exquisite art. Glass is made by the melting and fusion, at high temperature, of sand (silica) and some form of alkali, either sodium or potassium; various other ingredients are added for various kinds of glass, and as there are widely differing types of glass, so there are widely differing details in manufacture. All glass, however, is made of these prime ingredients by the process of melting them together, and it is blown, rolled, molded or shaped while in its molten state.

The manufacture and decoration of glass is a very old craft, so old that its origin is not certainly known. Both the Egyptians and the Phoenicians were familiar with it; Egyptian opaque glass of the 4th millennium B.C. exists, as do glass vessels made by Egyptians about 1800 B.C. It is thought probable that these master craftsmen invented glassmaking, and the Phoe-

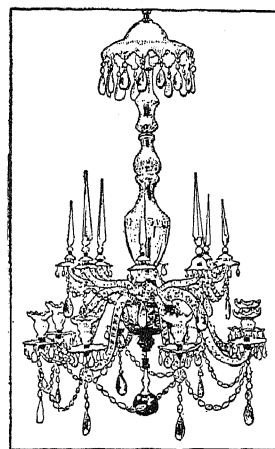
nicians, a traveling people, developed the craft and spread the knowledge of it. There exists Assyrian clear glass of about 700 B.C., and the Greeks are believed to have made glass about 600 B.C. But glassblowing was not invented until near the beginning of the Christian era by the Phoenicians at their great city of Sidon, a "glass center"; both Tyre and Sidon seem to have copied in glass the designs of Greek pottery. The Romans learned the craft of glassmaking, probably from conquered peoples, and brought it to a superb state of perfection in the days of the Empire. They mastered most of the technical processes in glassmaking, produced pure crystalline glass that was ranked with the precious metals in value, perfected the difficult "Cameo glass" of which the "Portland vase," broken in 1845, was the most famous example, made spun glass and *millefiori* glass and invented processes of applying gold leaf as ornament. Byzantine glassmaking flourished from the 6th to the 10th century, but was superseded by that of Venice as early as the end of the 11th century. This period marks the beginning of the great Venetian glass industry; in 1291 the larger furnaces were banished



COURTESY M. M. OF ART
EARLY 19TH CENTURY ENGLISH
CANDELABRUM WITH
HANGING CRYSTALS

from the city as a fire hazard, and the industry as a whole moved to Murano. Here glassmaking reached its zenith in the 16th century, and was artistically a Renaissance product. It is an interesting fact that the great period of STAINED GLASS brought a definite hiatus in artistic achievement in glassware, which had flourished before the Gothic era and was to flourish again after it. The Venetian glassmakers of Murano perfected the exquisite delicacies of lace glass, the highest development of the difficult thread glass; they wrought marvelous colors in *millefiori* glass, used gold traceries and gold leave work, did beautiful enameling on glass, imitated precious stones in colors, made crackled glass and other interesting varieties; the shapes of their vessels were also extremely beautiful. But when glass cutting was invented at Prague about the year 1600, Bohemia began to rival Venice as a glass-producing center. Although beautiful glass is still made here, and the craft has been subject to modern revival, Venice has never regained its old supremacy. With some interruptions cut glass has remained the most popular decorated form. The Bohemians did beautiful engraving on glass, and the Bohemian "gold sandwich" glass of the 18th century was also famous. In France, Germany and Spain the craft of glassmaking was continued from the Roman period. Glassworks were established in Normandy in 1330, and Colbert greatly stimulated glassmaking

in France in the 17th century, but the great French development of artistic glassmaking, which amounts to leadership, dates only from the late 19th century. In England a great step forward was taken in the invention in 1673 of "flint glass," a crystal glass made with an admixture of lead. It was fragile, but of great brilliance and beauty. This is used for tableware and cut glass, and since the English introduction of cutting and engraving from Bohemia in the first quarter of the 18th century, the making of cut glass has been a thriving British industry.

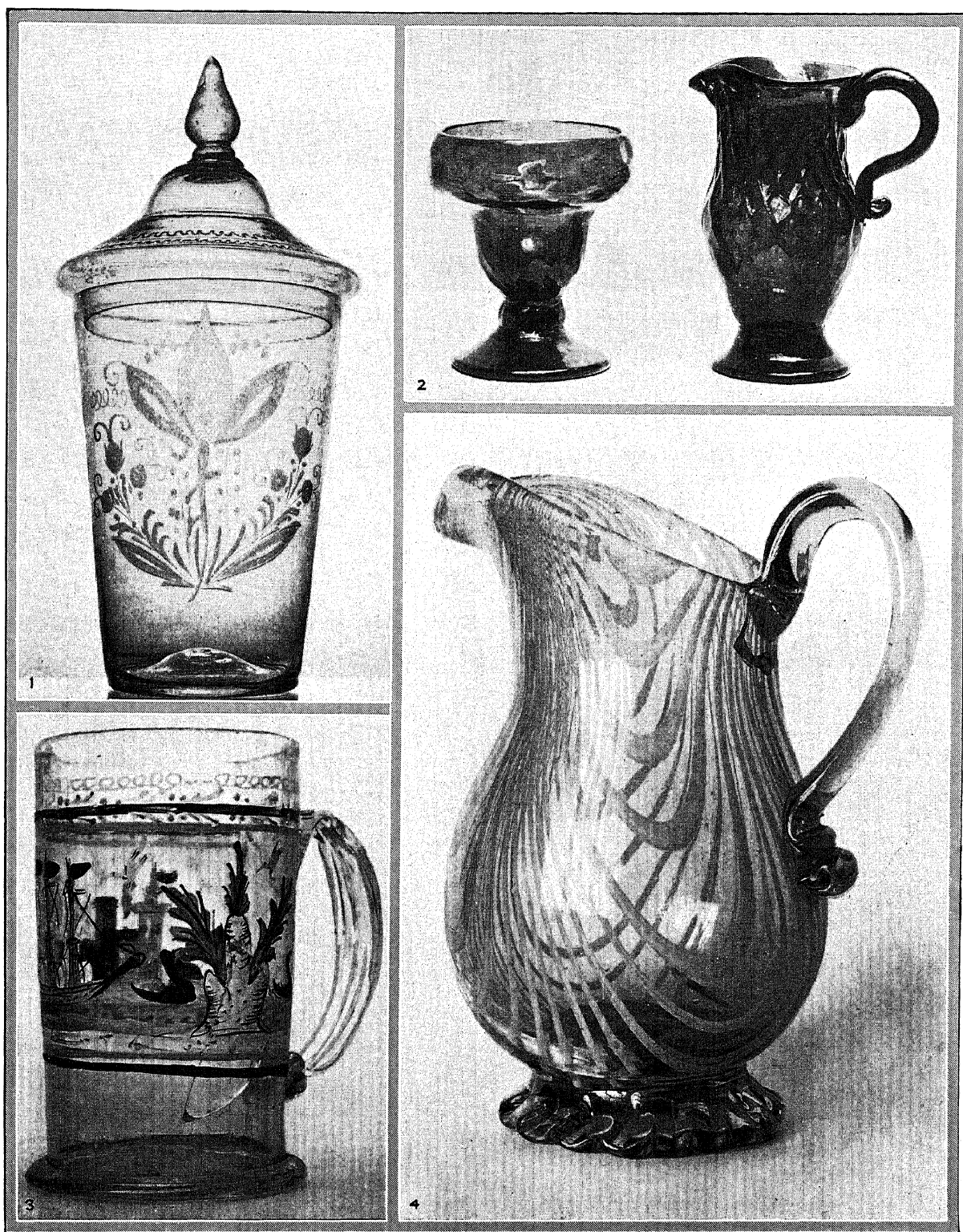


ENGLISH CUT GLASS CHANDELIER, 1750-1800

In America almost no glass was made before the 18th century. Casper Wistar's glassworks were established in South Jersey in 1732. Some 30 years later occurred the firing of the furnaces which produced the most beautiful glass ever blown in this country, that made at Mannheim in Lancaster County, Pa., by Henry William Stiegel between the years 1765 and 1774. The famous Sandwich Company of Massachusetts was founded in 1825. Stiegel's glass was probably the first flint glass manufactured in the United States; it was finer than the other early American glass, and it followed European fashions and designs in etching and color work. Unfortunately the unsettled business conditions of Revolutionary times brought Stiegel's enterprise to disaster. Workmen trained in his factory took their methods elsewhere, and as is also the case with Sandwich and Wistarberg, the name "Stiegel" came to be applied almost as a generic term. It is indeed difficult for the layman to distinguish between the different types of old American glass, but it is not necessary to be an expert to realize their beauty.

The modern development of glassmaking, after the decline which nearly all crafts suffered in most countries in the early 19th century, can probably be traced to the Paris Exposition of 1870. It is interesting to note that many of the French artists who have been its leaders were masters in other forms of creative design before they turned to glassmaking. E. Rousseau first worked with ceramics; René Lalique made jewelry; Maurice Marinot, probably the most celebrated of the moderns, was a painter, and his disciple, Henri Navarre, was a sculptor and designer. Navarre has been perhaps the most original of present-day artists in glass. Other French masters who have contributed to the present revival of art in glass are Émile Gallé of Nancy, very successful as a colorist, and Henri Cros and A. Dammouse, who have notably developed the treatment known as *pâte-de-verre*. Important work has also been done in Holland and Czechoslovakia. In the United States recent tenden-

GLASS



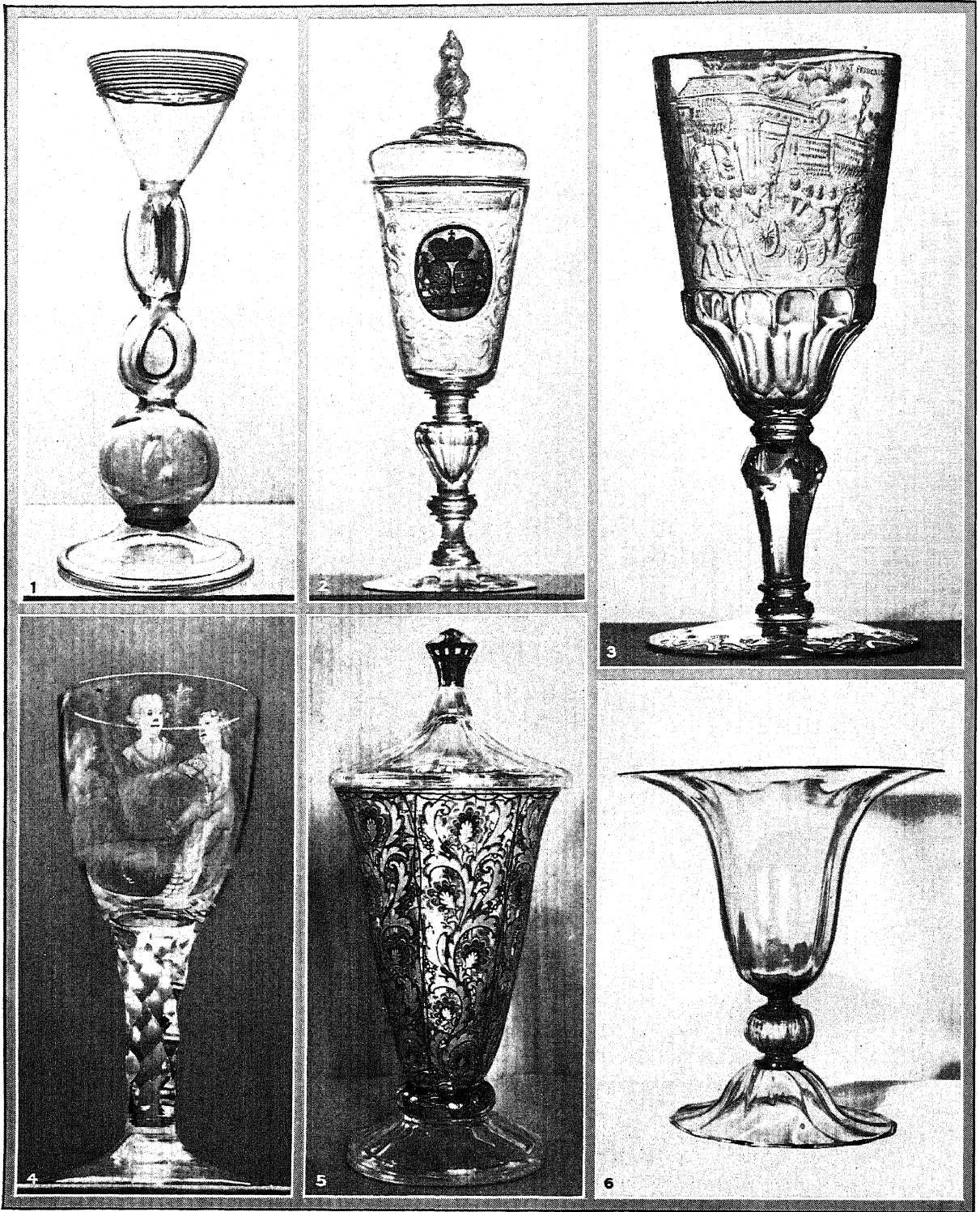
COURTESY METROPOLITAN MUSEUM OF ART

RARE EARLY AMERICAN GLASSWARE

1. Late American flip glass (18th century) from the Pennsylvania glasshouse of H. W. Stiegel. 2. Salt cellar and cream jug of Stiegel glass from Mannheim, Pennsylvania.

18th century. 3. Glass mug from New Jersey, late 18th century. 4. Green and opaque white pitcher of Wistarburg glass from Allowaystown, New Jersey. Late 18th century.

GLASS



1-4, COURTESY METROPOLITAN MUSEUM OF ART; 5, CONSULATE GENERAL OF CZECHOSLOVAKIA; 5, REHNQUIST PHOTO, COURTESY CAPPELLIN GLASSWARE, INC.

FINE EUROPEAN GLASSWARE

1. Colorless wine glass of the 17th century. Its graceful contours are characteristic of Venetian glassware. 2. Cup with cover and engraved decoration from Bohemia, early 18th century. 3. 18th century goblet from Germany, with an intaglio decoration commemorating the triumphs of

Frederick the Great in Silesia, 1745-46. 4. Dutch wine glass with a stippled decoration, by D. Wolff, about 1794. 5. Jar from Czechoslovakia illustrative of modern painting upon glass. 6. Colored vase of modern Italian workmanship, one of the most popular types of modern glass.

cies follow the lines of European development, but the favrile glass invented in 1890 by Louis Comfort Tiffany, also a painter, is a well-known American product. Mention of modern glass would be incomplete without reference to the surprising maturity of the craft in Sweden, where it was inaugurated only at the beginning of the 20th century. For the most part in solid colors, soft smoky tones, amber and green, and beautifully engraved and otherwise decorated, Swedish glass stands, since the Parish Exposition of 1925, in the forefront of European progress. It is interesting to observe that the process of commercial glass blowing has only recently yielded to complete mechanization.

Common glass, like that used for bottles, and window glass is made from white sand, pure limestone and soda ash, together with other chemicals. A large variety of chemicals is employed for making special glasses such as the finer table ware, art windows and oven glass.

Red glass is produced by the addition of gold, copper oxide or selenium; amber and yellow, with charcoal, uranium oxide, or cadmium sulphide; blue, with the oxides of copper and cobalt; violet, with manganese dioxide. The milk or opal glasses result through the use of bone ashes or minerals containing aluminum and fluorine.

The mixture of raw materials is called batch. This batch is melted in closed pots or in large tanks, the melting temperature ranging from about 2200 to 2700° F., and the melting time being 18 to 24 hours.

Glass may be pressed, blown, drawn or rolled. Products include WINDOW GLASS, PLATE GLASS, table ware, ornamental ware, apparatus for scientific use, OPTICAL GLASS, camera and telescope LENSES, and so forth, together with the colored glasses employed for traffic and other signals, art windows, and other ornamental purposes.

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GLASS, SAFETY. See SAFETY GLASS.

GLASS INDUSTRY, UNITED STATES. This industry comprises establishments devoted primarily to the manufacture of glass from raw materials. The principal products are plate and window glass; pressed and blown glass, including tableware, lamps, lamp chimneys, lantern globes, electric lamp bulbs, and tubing; containers for beverages, medicines, toilet preparations and food products, and general-purpose containers. In 1929 five states contributed 74% of the total output, namely Pennsylvania, 26.6%; West Virginia, 15.7%; Ohio, 12.2%; Indiana, 12.2%, and Illinois, 7.3%.

GLASS MANUFACTURE, U.S., 1899-1929

Year	No. Establishments	Wage Earners	Wages \$	Value of Products \$
1899	355	52,818	27,084,710	56,539,712
1909	363	68,911	39,299,624	92,095,203
1919	371	77,520	87,526,625	261,884,080
1929	263	67,527	87,795,111	303,818,560

GLASS CLOTH the name occasionally given to "sand" cloth. It is made by coating a strong cloth with glue and depositing fine particles of ground or broken glass on it before the glue has hardened. See SAND PAPER.

GLASS PAPER, similar to GLASS CLOTH except that the glue and the glass ABRASIVE are deposited on paper. See also SAND PAPER.

GLASSPORT, a borough of Allegheny Co. in southwestern Pennsylvania. It is situated 15 mi. southeast of Pittsburgh on the Monongahela River, and served by two railroads. The borough has glass factories, copperweld wire works, steel foundries and steel hoop and band mills. Glassport was incorporated in 1902. Pop. 1920, 6,959; 1930, 8,390.

GLASS PRINTS, or simulated etchings, also called *clichée verre*, consisting of drawings on varnished glass made for photographic reproduction. Several artists of the Fontainebleau group, notably COROT and Daubigny, experimented with this interesting process during 1853-74. The drawing is scratched with an etcher's needle on a glass plate, coated with white, opaque varnish, which rests on a black-covered table. As the point bares the glass, the lines show up in black against the white. To secure cleaner lines, a coating of printer's ink, powdered with white lead, is sometimes used in place of varnish. The finished transparency is printed on sensitized paper like a photographic negative. The lines of a glass-print, being of uniform depth, lack the quality given to true etching by successive bitings with acid, but this simple and inexpensive process offers a field to the modern amateur.

GLASS SNAKE, a legless lizard, common throughout the southern and central United States and parts of northern Mexico. This harmless creature readily sheds its tail when seized or persistently annoyed. The great length of this organ, together with the complete lack of legs, has doubtless led many observers to conclude that the animal's body has actually been divided into two or more pieces. A new tail grows after the loss of the original one but never attains the same length. The glass snake, *Ophisaurus ventralis*, is secretive in habits and reproduces by laying eggs. It feeds on insects, slugs and other small animals. Closely allied forms occur in the Old World.

GLASSWORT, the common name for a genus (*Salicornia*) of low fleshy herbs of the goosefoot family, called also marsh samphire. There are about 12 species of worldwide distribution in saline soils especially along seashores. They are plants of peculiar appearance with leafless, jointed stems filled with a salty sap. Due to their high content of soda, those of the common saltwort (*S. europæa*) were formerly much utilized in Mediterranean countries in the manufacture of glass and soap; the ash, known as barilla, obtained from the burned stems was long a staple article of commerce. The saltwort (*Salsola Kali*), a closely related plant, is sometimes called glasswort.

GLASTONBURY, a municipal borough of Somersetshire, England, situated on the Brue, at the foot of conical Glastonbury Tor, 143 mi. southwest of London. A legendary town, it was celebrated for the earliest Christian abbey in England, established by St. Joseph of Arimathea in the 1st century, and associated with SS. Patrick, David and Dunstan. Powerful, it survived Danish depredations and Norman confiscation. Several ancient churches and buildings survive in Glastonbury besides the Abbey fragments, and British and Roman relics have been discovered. The Glastonbury lake village was unearthed in 1892, in what are now meadows, recalling the legend that Glastonbury Tor was the Isle of Avalon. The modern town manufactures boots, tiles and cider. Pop. 1921, 4,325; 1931, 4,515.

GLASTONBURY ABBEY, a ruined Benedictine abbey at Glastonbury, Somerset, England. The first great Christian institution in England, the abbey traditionally was founded by St. Joseph of Arimathea. But it was probably established by Roman missionaries in 166. The original monastery was refounded in about 700 by the West Saxon king Ine, and here in the 10th century the Benedictine rule was established by St. Dunstan, who considerably enlarged Ine's venerable timber and wattle church. In the 12th century St. Dunstan's church was replaced by a larger Norman edifice; but this was destroyed by fire in 1184, and Henry II began reconstruction that was completed in 1303. Of this ancient abbey, which was suppressed by Henry VIII in 1539, the most noteworthy remains are the Chapel of the Virgin (late Norman), St. Joseph's Chapel (15th century), and the massive Abbot's Kitchen (c. 1440). In 1909 the site of the abbey was formally transferred to the diocesan trustees of Wells and Bath.

GLAUBER, JOHANN RUDOLF (1604-88), German physician and chemist, was born at Karlstadt, Franconia, in 1604. Little is known of him except that he lived successively at Salzburg, Frankfurt, Cologne and Amsterdam, practicing medicine and investigating chemical compounds. He improved the methods of obtaining saltpeter, charcoal and glass, and discovered the common purgative, Glauber's salt or sodium sulphate (*see* SODIUM). He died at Amsterdam in 1688.

GLAUBER'S SALT, a common name for sodium sulphate. *See* SODIUM; CATHARTICS.

GLAUCOMA, a disease of the eye, the principal manifestation of which is pressure within the eyeball. The direct cause of it is still unknown, but a large proportion of the blindness is due to it. It may be in the form of *simple glaucoma* which is a very insidious, non-inflammatory type, or *inflammatory glaucoma*, either acute or chronic, in both of which the eyeball is red and painful. *Secondary glaucoma* is merely a condition of increased intra-ocular pressure, due usually to a peculiar type of iritis and sometimes following injury. True glaucoma seldom occurs before the age of thirty-five years and then most frequently in far-sighted high-strung individuals. It is

said to be more common among Jews than other races.

In *simple glaucoma*, the patient is seldom aware of any ocular disturbance until there has been a marked loss of vision. Then careful examination is necessary to reveal the presence of the disease and the extent of its ravages. The main signs and symptoms are those due to the increased intra-ocular pressure, namely: a lessened distance between the cornea and lens, a somewhat dilated pupil that reacts poorly to light, a recession of the entrance of the optic nerve into the eyeball, more or less loss of vision, a marked constriction in the visual fields, and an intra-ocular pressure that may range from 35 to 70 mm. of mercury. (The normal intra-ocular pressure varies from 15 to 28 mm. of mercury.) The disease always affects both eyes, but is usually more advanced in one. Treatment consists in the use of miotics, drugs that contract the pupil, until such time as it can be shown that the disease is progressing despite treatment. Surgery must then be resorted to and it must be confessed that at least 90 per cent, if not more, of the cases of simple glaucoma must be operated upon at some time. Unless the increased intra-ocular pressure can be controlled, the eye will become blind from atrophy of the optic nerve and retina due to the pressure. Untreated, the average case will become blind in about two years. Under continued treatment and surgery, if necessary, about 70 per cent of the cases of simple glaucoma retain useful vision.

As its name implies, *inflammatory glaucoma* sets in with an acute attack of terrific pain, intense redness of the eyeball, sudden and nearly complete loss of vision, and increased intra-ocular pressure that varies from 70 to 110 mm. mercury. Usually one eye is affected at a time, but eventually the other eye becomes involved. Treatment must be instituted immediately and most rigorously, and unless effective reduction of intra-ocular pressure can be obtained in twenty-four to forty-eight hours, immediate surgical relief must be sought. If operation is postponed much longer than forty-eight hours (under continuous treatment) the chances of recovery of vision are small; but if immediate operation is successfully performed, useful vision is restored in a large percentage of cases. The operation of choice is the iridectomy, immortalized by von Graefe. In some cases, normal intra-ocular tension is obtained by treatment alone, but such individuals are almost sure to have further and more severe attacks. Consequently, it is advisable to perform an iridectomy upon every eye that has had an attack of acute inflammatory glaucoma. *See also* BLINDNESS, MEDICAL ASPECTS OF. H. S. G.

GLAUCONITE, a green mineral which forms on shallow sea bottoms, receiving fine sediments from the breaking down of siliceous rocks. As it usually occurs in granules or in sand-like deposits, it is commonly called greensand. Its composition is somewhat variable, but essentially it is a hydrous silicate of iron and potassium. *See also* MARL; OOLITE; SAND.

GLAUCUS, in Greek mythology, 1, the builder and steersman of the Argo, was drowned, but became

an ocean divinity. 2, A charioteer, son of Sisyphus, King of Corinth. 3, A Lycian prince who in the Trojan War changed armor with DIOMED and was killed by AJAX. 4, The son of MINOS II and Pasiphaë, smothered in a vat of honey and restored by Polyidus.

GLAZUNOV, ALEXANDER CONSTANTINOVICH (1865-), Russian music composer, was born at St. Petersburg, Aug. 10, 1865, of a musical family. He composed at an early age, while studying piano and theory. RIMSKY-KORSAKOV gave him lessons, Rubinstein conducted his *Overture on Greek Themes*, while LISZT furthered the progress of his works outside Russia. He became director of the St. Petersburg Conservatory in 1908, and remained at this post throughout the Revolution of 1917. On the 40th anniversary of his début as a conductor, the Soviet government gave him the title of "People's Artist of the Republic." His compositions include eight symphonies, a piano concerto, and the ballet, *Ramonda*, all marked by his superb orchestration.

GLEE, a part-song usually for male voices. Similar to the MADRIGAL, save that it is composed for solo voices rather than a chorus, the glee reached the height of its development during the late 18th and early 19th centuries in England where it became exceedingly popular, attracting the talents of such composers as Arne, Arnold, Webbe, Horsley, Paxton, Bishop, and Goss.

GLEIWITZ, a German city in the southeastern part of the Prussian province of Upper Silesia, in the mining and industrial section. Around the old city, new sections have arisen, and four rural suburbs were incorporated in 1927. A little town at the end of the 19th century, it rapidly became one of the centers of the Upper Silesian industrial district, due to the rich deposits of coal nearby. Apart from two medieval churches and an iron foundry of 1796, everything is new. Coal mines and iron foundries employ most of the inhabitants. Pop. 1925, 95,572.

GLENCOE, a glen in North Argyllshire, Scotland, about 90 mi. northwest of Edinburgh. Lying northeast of Buchaille Etive, the principal peak of which is 3,345 ft. high, it slopes northwest for 10 mi. to salt-water Loch Leven. The picturesque glen, walled by wild, craggy heights, is crossed by the Coe which forms small Loch Triochatan about the middle of the glen. Among the rocky bypasses is the cave in which Ossian traditionally was born.

GLENCOE, a residential city and suburb in Cook Co., northeastern Illinois, 24 mi. north of Chicago, on Lake Michigan. Glencoe is served by the Chicago and Northwestern Railroad and the Chicago North Shore Railway. The city was chartered in 1869. Pop. 1920, 3,381; 1930, 6,295.

GLENCOE, MASSACRE OF, an event in Scottish history that aroused much feeling against the English. The Highland Chieftains had been given until Dec. 31, 1691 to take oaths of allegiance to William and Mary, which they did reluctantly. Partly because of delay, and partly because of appear-

ing before the wrong magistrate, Alexander MacDonald of Glencoe was unable to take the oath before Jan. 6, 1692. The Government thereupon determined to make an example by exterminating his clan. Troops were sent to Glencoe for the purpose. For nearly two weeks they lived as guests of the clansmen, while arranging the details of the massacre. When the signal for the massacre was given shortly after midnight, Feb. 12-13, 1692, the plans miscarried, so that a number of the MacDonalds escaped, though 30 or 40 were killed and some died of exposure. Indignation was general, and after an investigation in 1695, the Scottish Parliament voted that "the killing of the Glencoe men was a murder."

GLEN COVE, a city in Nassau Co., a suburb of New York City, situated on Long Island Sound, N.Y., 22 mi. northeast of Brooklyn. It is served by the Long Island Railroad. Poultry raising and fruit and truck farming are the chief interests of the countryside. Glen Cove has various manufactures, including carbon paper, typewriter ribbons, hardware, textiles and photo-engraving materials. In 1929 the retail trade amounted to \$9,030,689. Morgan Memorial Park was given to the city in 1931 by J. Pierpont Morgan as a memorial to his wife. It has a quarter of a mile of water front. Glen Cove was founded in 1668. Pop. 1920, 8,664; 1930, 11,430.

GLENDALE, a town in Maricopa Co., southwestern Arizona. It is situated 9 mi. northwest of Phoenix and is served by the Santa Fe Railroad. Glendale lies in a diversified farming and poultry-raising region, and is the seat of a United States Government Experimental Poultry Station. Glendale, founded in 1890, was incorporated in 1910. Pop. 1920, 2,737; 1930, 3,665.

GLENDALE, a city of southwestern California, situated in Los Angeles Co., on the Los Angeles River, 15 mi. from the Pacific Ocean and 7 mi. north of Los Angeles, of which it is an attractive residential suburb. The Southern Pacific, Union Pacific and Santa Fé railroads, electric lines and an airport serve the city. Among the manufactures are pottery, laboratory products, trucks, airplanes and phonograph records. In 1929 the factory output reached approximately \$6,000,000; the retail trade amounted to \$36,145,512. Glendale was founded by Capt. C. E. Thom in 1887 and in 1906 was incorporated. Pop. 1920, 13,536; 1930, 62,736.

GLENDOWER, OWEN (c. 1359-1415), Welsh rebel, Lord of Glyndyrdwy or Glyndwr, was born in Wales about the year 1359. He was the last champion of Welsh independence and the last Welshman to claim the title of Prince of Wales. In 1400 Glendower led an uprising against HENRY IV in the belief that RICHARD II was still alive, and met temporary success. In 1404, he allied himself with CHARLES VI of France. During the next few years he had severe reverses, and was forced to retire to the mountains. After 1415 there is no authentic record of his life.

GLEN ELLYN, a residential city and suburb in Du Page Co., Ill., situated 20 mi. west of Chicago.

The city is served by two railroads. Glen Ellyn was founded in 1834 and chartered in 1882. Pop. 1920, 2,851; 1930, 7,680.

GLEN RIDGE, a borough of Essex Co., N.J., situated on New Jersey Route 23, 6 mi. northwest of Newark. A restricted residential community, it is a popular suburb for New York and Newark business men. Glen Ridge is served by the Erie and the Lackawanna railroads, electric trolleys and buses. Pop. 1920, 4,620; 1930, 7,365.

GLENS FALLS, a manufacturing city in Warren Co., eastern New York, situated on the Hudson River, 60 mi. north of Albany. It is served by the Delaware and Hudson Railroad, river craft, and steamboats on the Champlain Canal. The Floyd Bennett aviation field is near by. The city has large shirt, collar and clothing factories, pulp and paper mills. The value of its manufactured products for 1929 amounted to \$12,216,960. The retail business in 1929 reached a total of \$16,499,240. Limestone and fine black marble are quarried in the neighborhood. Abraham Wing and a handful of Quakers founded Glens Falls in 1763; it was known as Wings Falls until 1788 when it was renamed for Col. Johannes Glen of Schenectady. Glens Falls was incorporated as a city in 1908. The cave in the river bank is the scene of a part of James Fenimore Cooper's *The Last of the Mohicans*. The village was occupied by the troops of Generals Burgoyne, Schuyler and Gates during the American Revolution. In 1864, and again 1884, Glens Falls was almost completely destroyed by fire, but on account of its abundant water power for industrial purposes soon recovered. Pop. 1920, 16,638; 1930, 18,531.

GLENWOOD SPRINGS, a city in western Colorado, the county seat of Garfield Co. It is situated on the Colorado River, 126 mi. southwest of Denver. Bus and truck lines and the Denver and Rio Grande Western Railroad serve the city. Glenwood Springs is an all-year-round health resort, whose interesting features are hot mineral springs and vapor caves. The surrounding country produces potatoes, hay and grain. Pop. 1920, 2,073; 1930, 1,825.

GLIDER, a heavier-than-air craft without an engine. However, its wings, control surfaces and operating mechanisms are practically identical with those of AIRPLANES. In Germany, where gliding originated, they have been divided into three classes: 1. Primary Training Gliders, 2. Secondary Training Gliders, and 3. High-Performance Gliders, or Soaring Planes. The first class is characterized by rugged construction and by relatively poor aerodynamic properties (*see* AERODYNAMICS), the last class by a sacrifice in ruggedness to obtain high efficiency.

The aerodynamic efficiency of the glider is manifest in: The Gliding Angle, which is the angle that the flight path makes with the horizontal in still air; and The Sinking Speed which is the rate of loss of altitude under the same conditions. The higher the efficiency, the flatter the angle and the slower the sinking speed. It is customary to refer to a glider which has a sinking speed of less than 2.6 feet per

second as a soaring plane or, in Germany, a high-performance glider.

In the United States the same three classes are recognized as in Germany. However, there is a tendency to abandon the primary, secondary and soaring types in favor of the "utility" glider, which is rugged enough for primary training and at the same time efficient enough for soaring.

Glider loadings vary between two and three pounds per square foot of wing surface, giving normal gliding speeds around 20 to 30 miles per hour. The weight of gliders varies from 150 pounds for the light primary type to more than 400 pounds for some of the soaring planes. R. S. B.

GLIDING, heavier-than-air flight without engine power, accomplished by "coasting down-hill" on the air—the propelling force being that component of the force of gravity which acts along the path of flight, taking the place of the thrust of an AIR PROPELLER.

Gliding has been developed principally in Germany. There GLIDERS are launched by what is, essentially, an enlarged slingshot made of heavy elastic cord, a ring at the center of the cord engaging a hook in the nose of the glider. The two ends of the cord are pulled by manpower, the glider being restrained mechanically until sufficient tension is obtained in the cord to launch the glider. In the U.S. launching is done by automobile towing, where the terrain permits, and to a limited extent by airplane towing.

Gliding efficiency is generally measured by the horizontal distance that the glider will progress for a unit loss in altitude. For primary gliders, ratios of between 10 and 12 to 1 are usual, for secondary gliders, from 15 and 18 to 1 are common, for utility gliders about 17 to 1 may be expected and for soaring or high-performance gliders, between 20 and 30 to 1.

The Federation Aeronautique Internationale, represented in the U.S. by the National Aeronautical Association, issues two classes of gliding license and one soaring license. The lowest, or "A" license, is issued for a gliding flight of at least 30 seconds duration. The second, or "B" license, is awarded for a glide of at least one minute duration, during which time two full "S" turns must be made.

The Aeronautics Branch of the Department of Commerce issues two grades of glider license, a private license for which the candidate must show his ability to make gentle turns and a good landing, and a commercial license which requires 360° turns and landing close to a pre-designated spot. The commercial license is mandatory for those who are paid for gliding or for teaching gliding. *See also* SOARING. R. S. B.

GLINKA, MICHAEL IVANOVITCH (1803-57), Russian music composer, was born at Novospasskoi, June 2, 1803. The folk element of Russian music influenced his whole career. After three years spent in Italy he returned to Russia in 1836, and produced *A Life for the Tsar*, an opera replete in Russian-Polish rhythms. In 1842 another opera, *Russland and Lioudmilla* was successfully produced. He died at Berlin, Feb. 15, 1857.

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